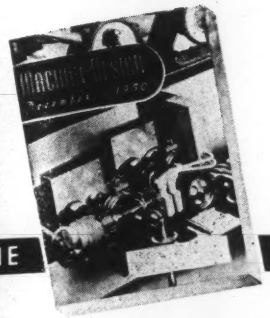


This Month's Cover: Systematic design, discussed in the article beginning on Page 126, was employed by Askania Regulator Co. in developing this electromechanical unit for generating functions of natural logarithms.

MACHINE DESIGN

Vol. 22—No. 12 December, 1950

THE PROFESSIONAL JOURNAL FOR ENGINEERS AND DESIGNERS

EDITORIAL STAFF

COLIN CARMICHAEL *Editor*

JOHN W. GREVE, *Managing Editor*
ROGER W. BOLZ, *Associate Editor*
BENJAMIN L. HUMMEL, *Associate Editor*
ROBERT R. HARNAR, *Assistant Editor*
ROBERT E. DENEGA, *Assistant Editor*
ROSEMARY A. KITSKO, *Editorial Assistant*
JANE H. SMITH, *Editorial Assistant*
FRANK H. BURGESS, *Art Editor*
LAURENCE E. JERMY, *Consulting Editor*

New York ..... B. K. PRICE, L. E. BROWNE
Chicago ..... ERLE F. ROSS
Pittsburgh ..... J. C. SULLIVAN
Detroit ..... H. C. TUTTLE
Washington ..... E. C. KREUTZBERG
London ..... VINCENT DELPORT

BUSINESS STAFF

ROBERT L. HARTFORD *Business Manager*

MARY L. CALLAHAN, *Advertising Service*

JACK C. GERNHARD *Circulation Manager*

Chicago
H. H. DREYER R. K. LOTZ

New York
R. H. SMITH E. S. LAWSON

Cleveland H. B. VEITH
Los Angeles F. J. FULLER

Main Office

Penton Building, Cleveland 13, Ohio
Main 1-8260

Branch Offices

New York 17 ..... 60 East 42nd St. Murray Hill 2-2581
Chicago 11 ..... 520 North Michigan Ave. Whitehall 4-1234
Pittsburgh 19 ..... 2837 Koppers Building Atlantic 1-3211
Detroit 2 ..... 6560 Cass Ave. Trinity 5-3024
Washington 4 ..... 1123 National Press Bldg. Executive 6849
Los Angeles 4 .. 130 N. New Hampshire Ave. Dunkirk 2-1758
London, S.W.1 .. 2 Caxton St., Westminster

Published by

THE PENTON PUBLISHING COMPANY

E. L. SHANER ..... *Chairman*
G. O. HAYS ..... *President and Treasurer*
R. C. JAENKE ... *Vice Pres., Director of Adv.*
F. G. STEINEBACH .. *Vice Pres. and Secretary*
R. W. COLEMAN ..... *Asst. Treasurer*

Also publisher of STEEL • THE FOUNDRY NEW EQUIPMENT DIGEST

Published on the seventh of each month. Subscription in the United States and possessions, Canada, Cuba, Mexico, Central and South America: One year $10. Single copies, $1.00. Other countries one year, $15.

Copyright 1950 by The Penton Publishing Company.

Acceptance under Act of June 5, 1934. Authorized July 20, 1934.

CONTENTS

Not a Machine But a Life (Editorial) 111

Design for Safety 112
By Sigurd K. Rudorf

Scanning the Field for Ideas 119
Telemetered vibration data—electronic flowmeter—self-powered control—vibratory ball mill

Three-Dimensional Photoelasticity—new creeping method 122
By A. J. Durelli and R. L. Lake

Systematic Design of Mechanisms 126
By H. Ziebolz

Heat Treatments—Part 3—Combination Hardness and Toughness 137
By Norman N. Brown

High-Speed Motion Pictures—detect defects in design 143
By L. G. Waller

Contemporary Design 146
Thread roller—magnetic-roller shear—air circulator—wrapper for textiles—metallograph—thread winder

Why Machine Parts Fail—Part 8—When Not To Blame the Designer 151
By Charles Lipson

Design Details for Stamped Parts (Production and Design) 157
By Dayton A. Rogers

Designing for Shock Resistance—Part 1 161
By Charles E. Crede and Miguel C. Junger

Designing a Large Weldment 168
By L. G. Hauser

Stepped Film Bearings 171
By Frank R. Archibald

Helical Springs (Data Sheet) 173
By John H. Keyes

Design Abstracts 175
Gas-turbine truck — engineer and public relations—styling

DEPARTMENTS

Topics 108
New Parts and Materials 178
Engineering Dept. Equipment . 188
Helpful Literature 191
Men of Machines 194
Noteworthy Patents 200
The Engineer's Library 206

News of Manufacturers 212
Society Activities 220
Sales and Service Personnel .. 226
Sales Notes 234
Meetings and Expositions 238
New Machines 240

Itemized Index 7
ANNUAL INDEX OF EDITORIAL CONTENTS 254

DESIGNING FOR PRODUCTION AND SALES • STYLING
MATERIALS SPECIFICATION • DESIGN ANALYSIS
MACHINE COMPONENTS • ENGINEERING MANAGEMENT

MD

Another Goodyear First—

A new cord material that gives V-Belts

40% higher HP ratings Highest shock-load resistance without excessive stretch

HEART of these belts is a new, chemically produced fiber that has nylon's *strength, without its stretch*. This newly developed material is the reason why HY-T Multi-V-Belts boast horsepower ratings 40% above ordinary belts.

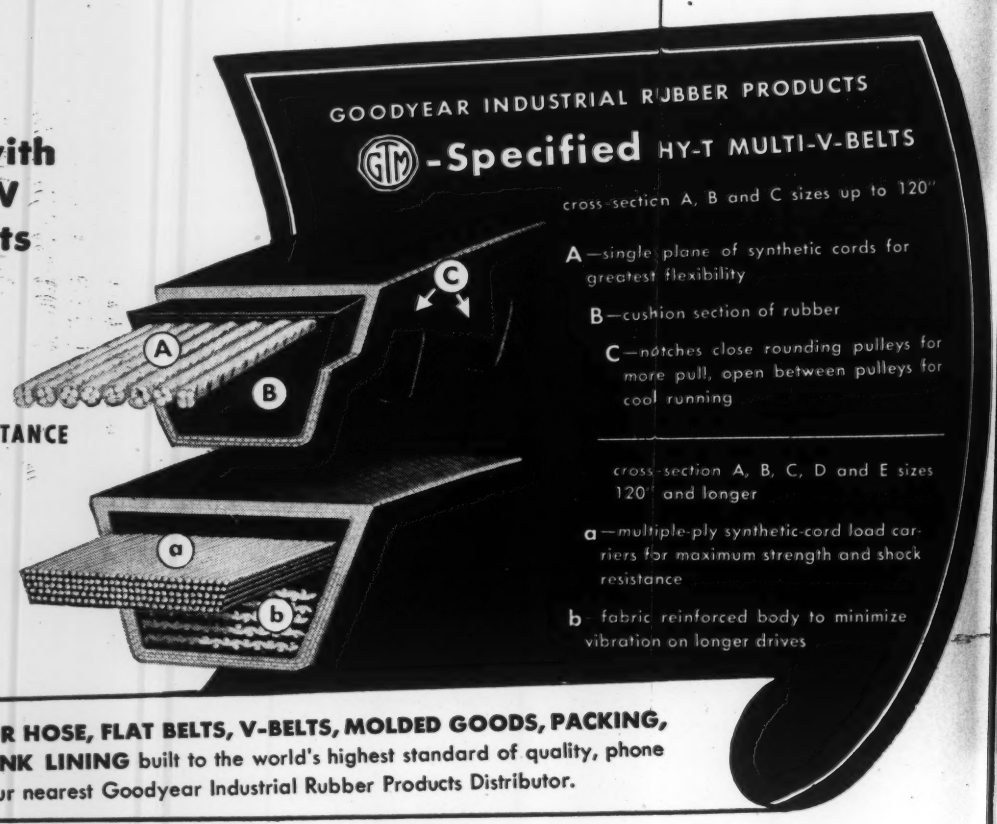
That means you can handle heavier loads with fewer belts—7 HY-T belts will walk away with a load that requires 10 regular belts! What's more, they're built to take heavy shock-loads in stride—give outstanding flex-life on *all* diameter sheaves, and at all speeds within Goodyear or RMA recommendations.

Now V-Belt users everywhere can get the ideal combination of characteristics for heavy-duty, high-shock-load service with Goodyear's NEW HY-T belts. Designed to meet the most exacting requirements—tested on hundreds of tough drives—these belts are now in production and will soon be available in standard sizes through your nearest Goodyear Industrial Rubber Products Distributor.

Ask the G.T.M.—Goodyear Technical Man—or your nearest Goodyear Distributor to show you how to end your drive problems with this new belt that has the highest HP rating and longest flex-life of any fiber construction belt on the market. Or write Goodyear, Akron 16, Ohio.

You get all nine with Goodyear's NEW HY-T Multi-V-Belts

- HIGHER HP RATING
- REDUCED STRETCH
- LONG FLEX-LIFE
- HIGH SHOCK-LOAD RESISTANCE
- COOL RUNNING
- OIL RESISTANCE
- RESISTS AGING
- STATIC CONDUCTION
- MILDEW RESISTANCE



FOR HOSE, FLAT BELTS, V-BELTS, MOLDED GOODS, PACKING, TANK LINING built to the world's highest standard of quality, phone your nearest Goodyear Industrial Rubber Products Distributor.

GOODYEAR

THE GREATEST NAME IN RUBBER

HY-T—T. M.
The Goodyear Tire & Rubber Company,
Akron, Ohio

..the chains that serve EVERY industry..

..in conveying and power transmission..

..are the chains that meet your exact need..

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities.

11,354-1

..Chain--by LINK-BELT

TOPICS

STROBOSCOPE for "stopping" motions recurring as often as 300,000 times per second has been developed by the Naval Ordnance Laboratory. Instead of synchronized high-intensity flashing light, an electron tube with variable pulse rate illuminates the subject. The observer watches the action through a fluorescent viewing screen. Also, with the tube serving as a camera shutter, photos can be made with 16-mm lens.

SURFACE CARBON CONTENT of steel during carburizing is automatically controlled by a new Leeds and Northrup instrument. Carbon potential of a furnace atmosphere is "sensed" by an electrical element projecting into the furnace work chamber. Connected to this element is a unit which adjusts the flow of carburizing fluid to hold the potential at any selected value between 0.15 and 1.15 per cent carbon.

STRAIN GAGES are being used as fuel gages for rockets in NACA laboratory tests. Attached to the structure supporting the liquid-fuel tanks, the gages indicate tank weight and, thus, fuel content.

ELECTRIC GOVERNOR being developed by the Navy for small generating plants reacts to any change in load current instead of generator speed. The generator will restore engine speed and frequency to within 0.5 per cent within one-half second after change from 0 to 100 load and will maintain steady load speed within 0.25 per cent.

STAINLESS STEEL discolored in welding can be cleaned by a method developed by Armco Steel Corp. With an acid solution (phosphoric, nitric or hydrochloric) a direct-current power source and a copper "cleaning" rod, discoloration can be removed at a rate of two feet per minute. Light scale also can be removed but not heavy scale or weld slag.

HOT-LACQUER PROCESS, wherein lacquer is heated to make it more fluid and sprayed while hot, is proving to be an economical finishing method. According to Hercules Powder Co., solid content of the lacquer can be increased from 21 to 30 per cent. With higher solid content, less solvent is wasted, fewer coats are needed, and properties such as "flow-out," sag resistance, and toughness are improved.

BOROCARBON RESISTORS offering resistance ranges heretofore impossible with stable film type resistors have been developed by Bell Telephone Laboratories. In the new resistor, borocarbon films are deposited on a suitable ceramic core by the thermal decomposition of gaseous compounds of these elements. The relatively small and predictable temperature coefficients of the resistors depend on film thickness and boron content.

MARKINGS ON STAINLESS STEEL can be permanently applied by a method developed by Stainless Ornamentals Inc. Designs or markings are black and are claimed to have anticorrosive qualities equal to stainless steel. The process is applicable to dials, signs, name plates, etc. Photographs (up to 132 screen halftones) can be reproduced on stainless steel also.

OCTOPROP, an 8-blade dual-rotation airscrew, is being tested by the Air Force. Designed by Curtiss-Wright, the unit is 19 feet in diameter and has been planned for operation with turbo-engines up to 15,000 horsepower.

SILICONE RUBBER of a new type has been developed by General Electric. Parts can be fabricated from the new compound without prolonged oven cure and may easily be molded and extruded after a five-minute warm-up. Parts with undercuts can be easily removed from molds because of high hot-tear strength. The rubber remains serviceable over a temperature range of 550 to −85 F.

HUMAN ENGINEERING DATA has been compiled at Tufts College under Navy contract in the form of a systematic treatise on the science of designing mechanical equipment consistent with human capabilities. Entitled *Handbook of Human Engineering Data for Design Engineers,* the book deals with vision, hearing, motor responses, space orientation, anthropometrics, and physiological factors.

MACHINE DESIGN
A PENTON PUBLICATION

. . . Not a Machine But a Life

SOMETIMES it appears that the ingenuity of machine designers in devising clever mechanisms is matched by the ability of machine users in finding ways to injure themselves and damage the mechanisms. Wherever there are moving parts, of course, there is potential hazard to life, limb and property, although most of the present machinery-conscious generation has acquired a healthy respect for the dangers. However, there are still the clumsy ones, the foolhardy ones, and the deliberate tamperers.

Accidents are at best unpleasant occurrences. We would like to look the other way and shrug them off as consequences of carelessness. But as Sigurd Rudorf points out elsewhere in this issue, every so-called human failure in the operation of machinery can be charged, at least in part, to the designer.

Unfortunately many machinery accidents are followed up merely by a tightening of safety regulations and possibly also by the addition of some sort of makeshift safeguard to the machine involved. The one step that would get to the heart of the matter and really promote long-range safety too often is omitted—that of notifying the machinery manufacturer concerning all details of the accident, so that the necessary safeguards may be incorporated in future designs and, possibly, modifications made available to other users of existing machines.

Initiative for a positive program to insure that designs will meet all reasonable—and perhaps some unreasonable—safety requirements must come from the engineering department of the machinery builder. What steps might be taken to start a program of this kind? Rules such as those suggested in Mr. Rudorf's article can be formulated and established as part of standard design procedure. Users can be encouraged to submit data on any accidents, perhaps by such devices as periodic questionnaires which would make it easy to report the details. Quite apart from the economic soundness of designing for safety is the human appeal, which should be effective in enlisting the enthusiastic co-operation of all concerned. As James E. Trainer recently told the Gray Iron Founders' Society, the objectives might be stated in terms of saving not a camera but an eye, not a compressor but a lung, not a pump but a heart, not lubricant but blood, not a machine but a life.

Colin Carmichael

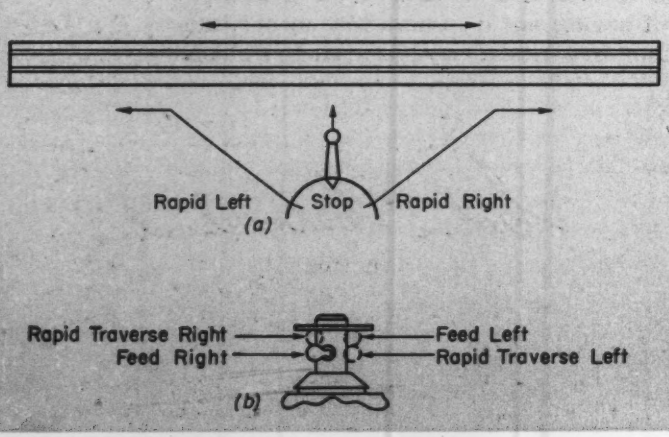
EDITOR

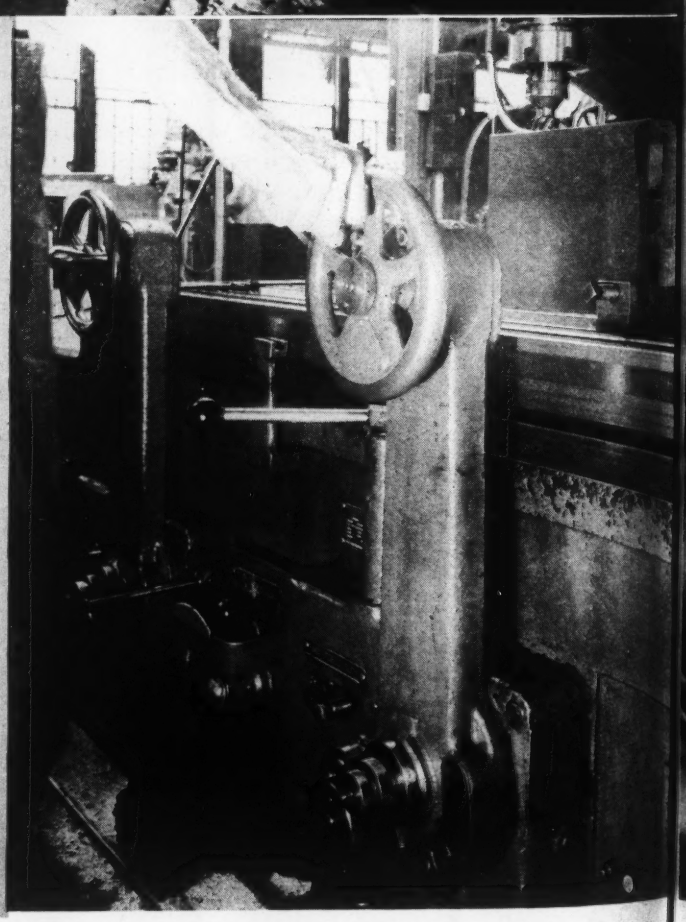
Fig. 1—Above—Nonfunctional control design, explained in Fig. 5, was a major factor in this $50,000 smash up

Fig. 2—Below—In functional control-lever design (a), response is in same direction as movement of lever and speed increases with lever displacement. In nonfunctional design (b), if "up" and "right" produces "feed left", operator would logically assume that "up" and left" would produce "feed right." Getting "rapid" instead has led to machine damage and personal injuries

Fig. 3—Right—Motion of the table is directly proportional to handwheel rotation in this application of directional rotary servo control to a milling machine

Fig. 4—Extreme right—This detent-type directional control is simple but effective





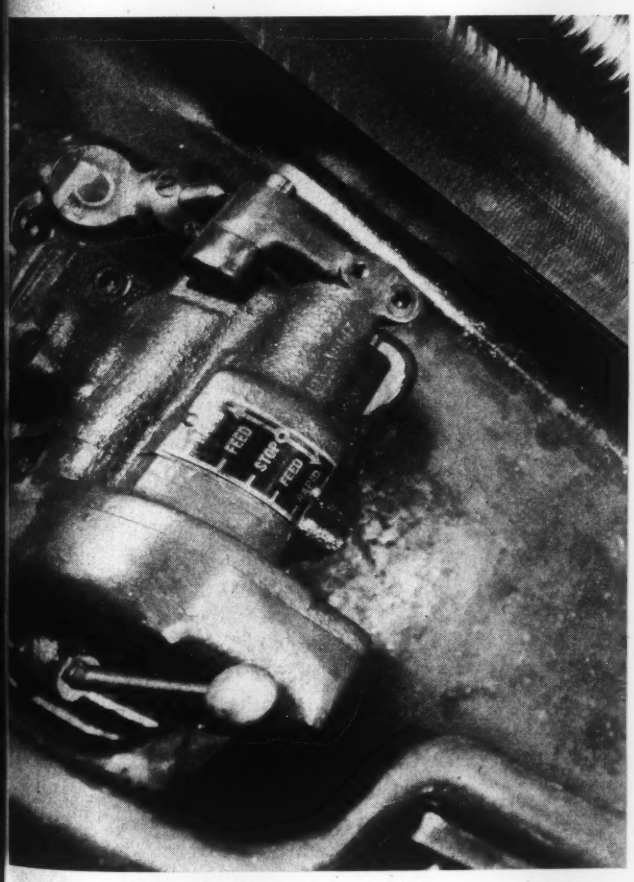
Design for Safety

How machine designers can improve controls and reduce costs while promoting safe operation

By Sigurd K. Rudorf
Superintendent, Maintenance
General Machinery Div.
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

COMPLETING an uneventful flight some time ago, a huge four-engined airliner gracefully touched its wheels to the runway at Shannon Airport, Ireland. During the landing run, the pilot called for "up flaps", a routine function of the co-pilot. Seconds later the $1,300,000 airplane was a pile of junk.

The investigation that followed revealed that a simple and human mistake was a basic cause of the accident. The copilot, familiar with the control locations of another type of plane he had flown for many months, inadvertently operated the landing gear lever, retracting the wheels and dropping the moving plane to the pavement.



Investigators attributed this spectacular disaster to human failure alone (as we are apt to do when a machine operator runs a carriage beyond its limits, or plows a fixture off a milling machine table because a control-lever action is alien to him). But this crack-up and other hard lessons have led the aircraft people to do more constructive work on control simplification and standardization than any other group.

They have devised control knobs of contrasting shapes with functional movements in logical locations, have grouped instruments to facilitate reading, and have done much other constructive work. This was brought about by the aircraft industry's recognition that not every "human" failure can be attributed solely to the operator but, in part, must be charged to the machine designer.

In this same sense, machine builders cannot escape a measure of criticism of their products. Although most of them state that they have given much thought to functional controls, the products of their labors often fail to reflect this endeavor, *Fig.* 1.

The purpose of this article is to discuss a number of safety thoughts from a machine user's point of view, without dwelling long on spinning handwheels and other well-known ghosts. Although the connection of these thoughts to safety considerations is not always direct or even clear, this discussion is predicated on the premise that when the designer simplifies controls, removes distraction and doubts, and eliminates need for close concentration, he directly or indirectly promotes accident prevention and reduces costs. In this spirit, the following recommendations are made.

Several obvious fundamentals apply to the design of control levers. All control levers should be so ar-

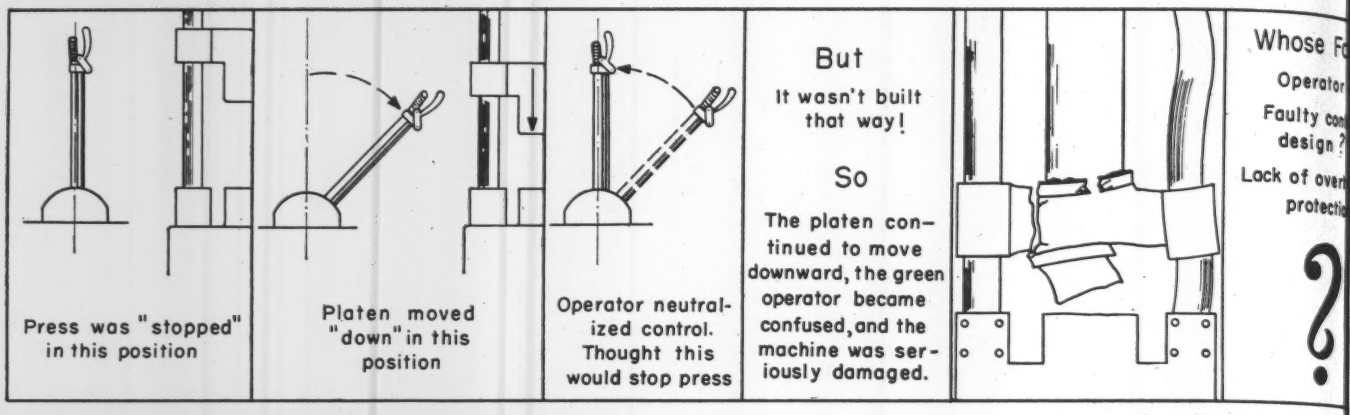


Fig. 5—Above—This is the story of the mishap shown in Fig. 1

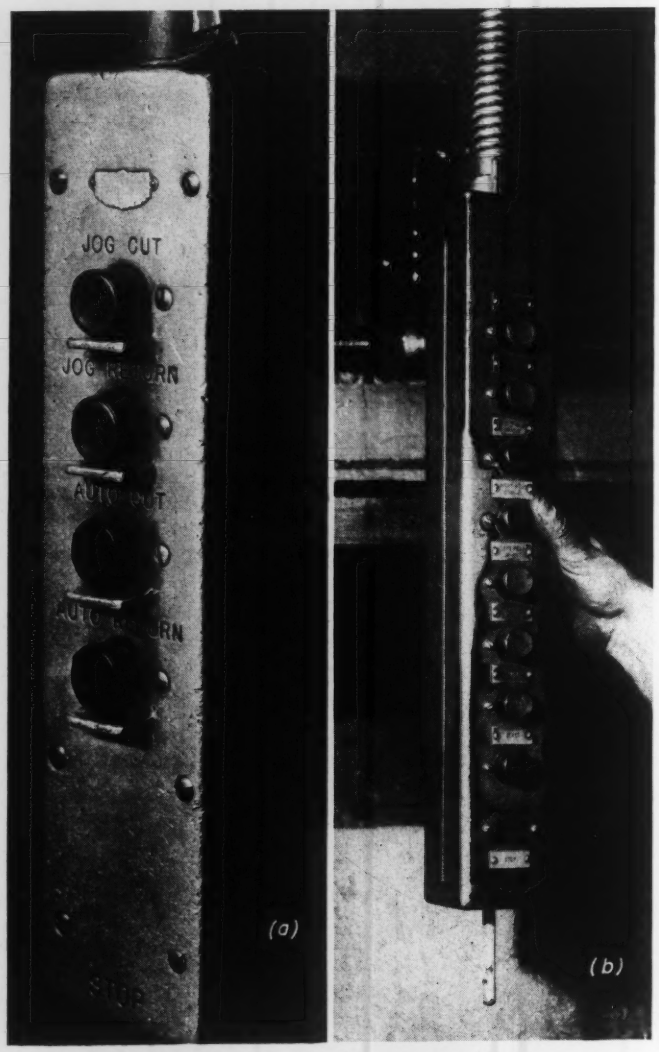


Fig. 6—Left—Controls should be positively identified. Panel arrangement (a) shows one of many ways to relate each button to its name plate. As in (b) confusion can result from failure to "tie up" a button and its identification

Fig. 7—Left below—Many common control peculiarities are traditional but still confusing

ranged that machine components move in the direction in which the lever is moved, *Fig.* 2. So far as possible, a *small* movement of the lever should initiate "feed", or slow movement. A *further* movement should produce "rapid traverse", or accelerate motion, *Figs.* 3 and 4. Accidental overmovement into "rapid" position must be prevented by a thumb-operated latch or similar lock gate.

Several motions of a machine, where possible, should be combined into a single "joy stick" type of control. For instance, the table of a knee-type milling machine could be operated by a single perpendicular control stick which could be moved progressively to two positions in each of four directions. "First position right" would cause the table to feed to the right. "Second position toward column" would rapid-traverse the table toward column, etc. The reasoning here is that a single lever would become associated with the table. The directional feature is as elementary as leading the proverbial horse to water.

If *moving* a lever to a given position produces a given motion, *returning* the lever to its original position should *arrest* the motion. *Figs.* 1 and 5 graphically show the results of one violation of this rule.

Controls should be so marked that the name plate clearly identifies the control function, *Fig.* 6*a*. Obviously, in an emergency there is no time to check if the button *above* or *below* the inscription is meant, *Fig.* 6*b*. Although it is difficult to depart from time-honored control peculiarities, uniformity should be a goal, *Fig.* 7.

Machine components should be so arranged that they are protected against overtravel. Preferably this protection should be provided through automatic declutching of drive gearing, de-energizing of driving motors, through overload friction or ratchet clutches, or as a last resort, through shear pins. Simply indicating by a line or marker that feed must be discontinued at a certain point is not sufficient. Un-

fortunately, a lathe compound cannot be protected against being carelessly run against a work piece. The odds are against it, though, since the operator is more likely to be watching the tool (and therefore the compound) in relation to the work. However, protection should be planned against inadvertently running a slide into its "dead end" with consequent damage to the machine.

Speaking of overloads—few machines are potentially as dangerous as overhead cranes. They are frequently subjected to abuse through overloading. Yet, they are among the least protected against either accidental or willful damage. Most cranes will lift loads that are great enough to tear cables, deform bridges, or damage brakes. It is recommended that cranes be so arranged that it is impossible for the operator to pick up unsafe loads without being warned or using emergency procedures.

No machine builder is expected to be conversant with the different and changing safety codes of the 48 states. The National Machine Tool Builders' Code is a welcome step in the direction of standardization. It is expected, however, that all agents selling machine tools should be sufficiently familiar with the codes of the states in which they do business to point out to users the ways in which their products meet with local law or fail to comply, and to convey to their principals the modifications needed for acceptance.

It is not expected that the builder of a $150.00 drill press should make individual changes to satisfy local requirements. It is expected, however, that builders of major or special machines should comply with state laws. For several years at Allis-Chalmers, it has been gratifying to note that after insistence that the equipment covered by purchase orders meet local state code requirements, no refusals have been encountered and no requests received for additional remuneration. Builders apparently feel that such requests are reasonable.

As an aid to safety as well as to getting the most

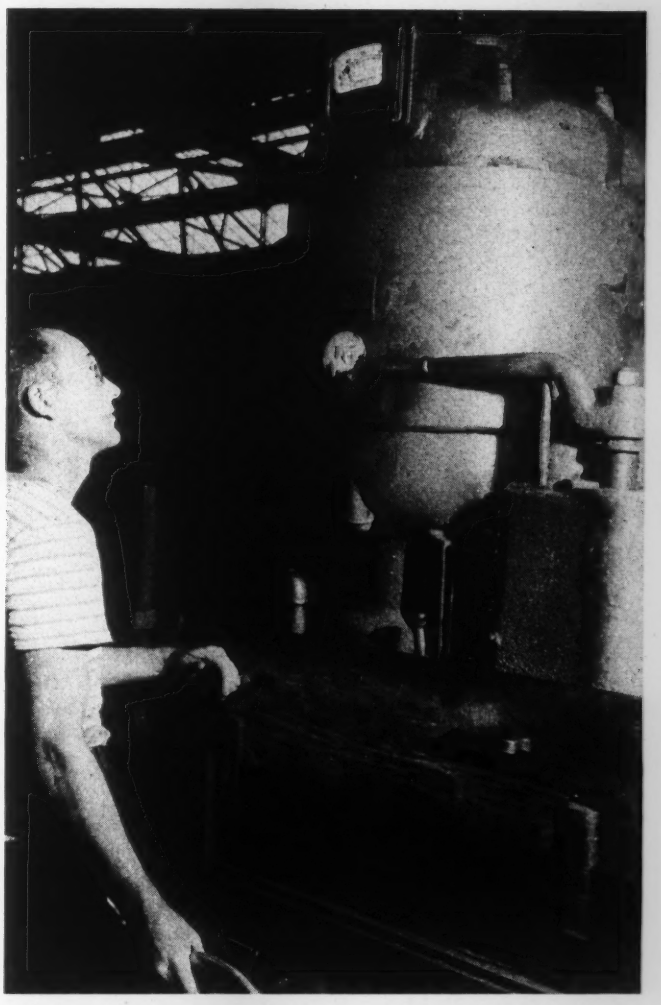
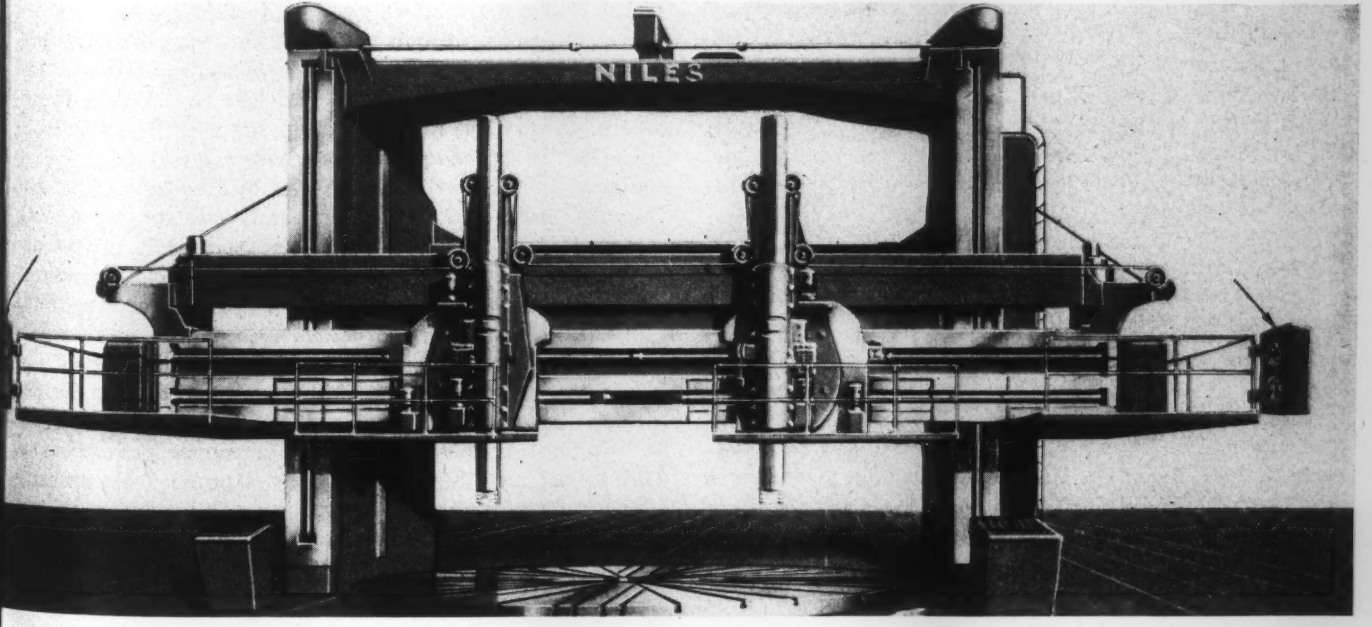


Fig. 8—Above—On grinding machines electrical load indicators are frequently the only practical means of limiting the feed rates to those that work and machine can stand

Fig. 9—Below—Large machines afford an operator no "feel" of load and tool pressure; he must rely on instrumentation. On this 30-ft boring mill, with dual variable-speed constant-torque drive, meters indicated by arrows show percentage of available horsepower being consumed by the cut as well as feed rates and table speed



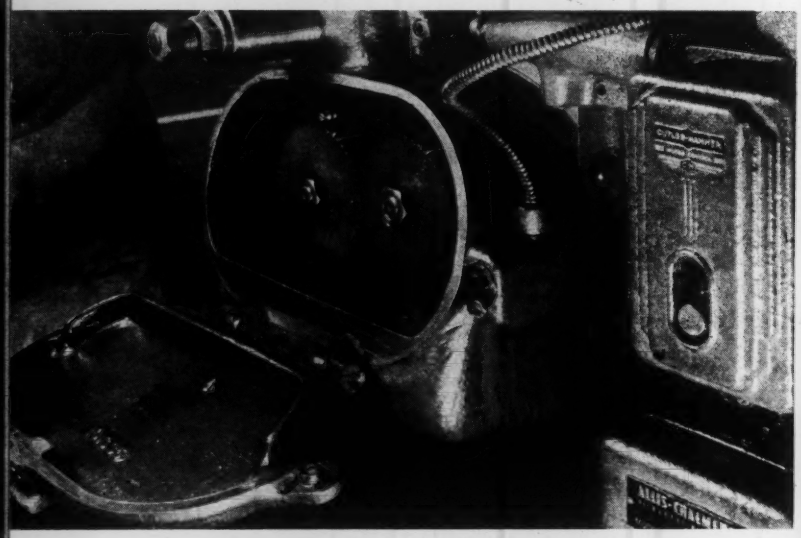


Fig. 10—Above—As shown here, gear box covers and other access doors should be electrically interlocked to prevent accidental starting

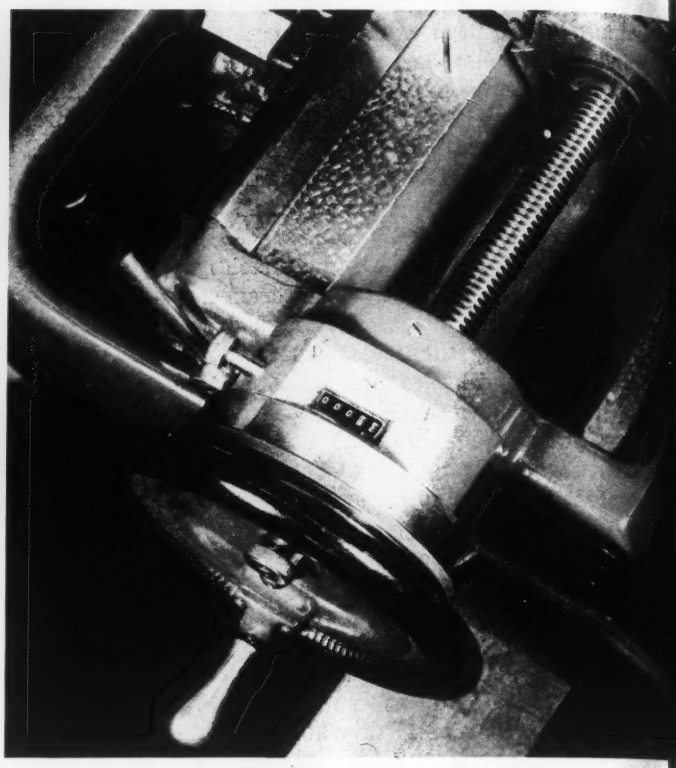


Fig. 11—Right—To prevent confusion, means of measurement should be direct and simple. Good design is exemplified by this drum counter with conventional vernier collar for a modern jig-boring machine

out of a machine, indicators should be provided to show the horsepower consumed with a given cut, *Figs.* 8 and 9. In the case of variable-speed d-c equipment, it should show the percentage of available power being used, since horsepower may vary with speed. These readings would help the operator produce more work as well as protect the machine against mechanical abuse.

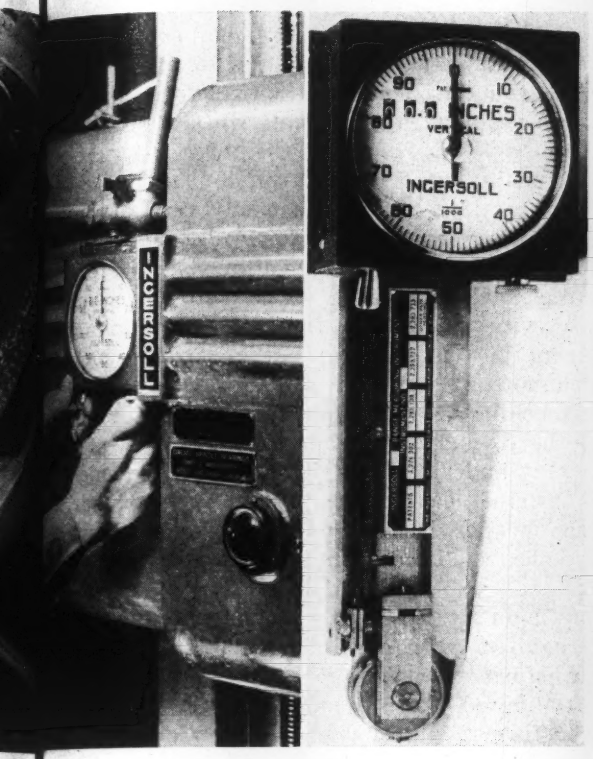
Pick-off gear box covers and other frequently used access doors should be electrically interlocked to prevent accidental operation and injury, *Fig.* 10. Although some builders have done this for many years, not all have followed this practice.

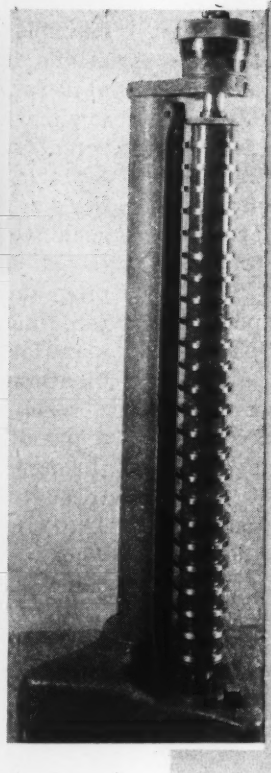
Air-chuck equipped machines are usually provided with pressure switches to shut down the spindles when work-holding forces drop below predetermined values. This practice should not only be universally followed, but care must be taken that there is sufficient reservoir capacity in the piping system (or check valves provided) to assure that, even in the event of pipe joint rupture or hose failure, enough air is trapped to hold the work until the spindle has been brought to a stop. Installations have been observed where the pressure switch would not have prevented an accident if any of a variety of possible failures had occurred.

The number of different types of graduated collars on handwheel hubs is a frequent source of error. Certain lathes have cross-feed graduations representing the true advance of the cross slide. In other words, feeding the wheel 0.010-inch would reduce the workpiece diameter by 0.020-inch. In a questionable effort toward simplification, other machine builders make their graduations represent one-half of true motion, so that rotating the wheel 0.010-inch produces 0.005-inch forward motion, with a resultant 0.010-inch reduction of workpiece diameter. To add to the general confusion, series of two or three geared dials are sometimes used, reading in inches and thousandths. Both opposite and like rotation have been used. Although direct-reading drum counters or dial-drum combination units, such as illustrated in *Fig.* 11, are favored, it is believed that an effort toward standardization by the industry as a whole might produce less expensive solutions.

A fundamental of the manufacturing business is precise measurement. The scale, even when vernier equipped, is inaccurate and produces eye fatigue accompanied by errors. Length measures and indicators, such as used on jig borers, are accurate but slow. Electrical positioning-to-length measures are better, but expensive and still too slow. Geared drum counters cannot stand high speeds resulting from fast traverses. Dial-drum type measuring instruments are a close approach to a solution, *Fig.* 12, but present accuracy problems where traverse distances are more than a few feet. It must be concluded, therefore, that the problem is not solved. The ideal objective is to show dimensions accurately to four places as sets of figures on well lighted dials. Thought might be given to an interim solution: confining measurements to the short distances that can be accommodated by present day dial indicators, say 1 inch, and obtaining the major portion of the total distance from racks or bars with 1-inch pitch reference surfaces. In other words, this could be an application of the principle exemplified by the height gage shown in *Fig.* 13.

Coolant reservoirs and chip removal provisions at long last are beginning to be studied. Necessarily and certainly traditionally, ways are often placed where they take the brunt of chips, coolant and falling parts. Certainly it is not inconceivable that lathe ways might be arranged to the *rear* of the





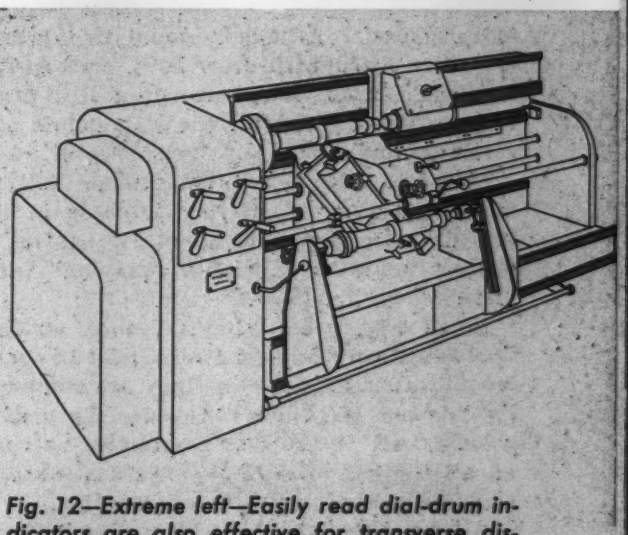


Fig. 12—Extreme left—Easily read dial-drum indicators are also effective for transverse distances up to several feet

Fig. 13—Left—A possible solution to the problem of accuracy over great distances is suggested by this height gage which combines a series of 1-inch reference blocks

Fig. 14—Above—Damage to lathe ways from chips, coolant, falling parts, etc. might conceivably be prevented by a revolution in lathe design. Special covers and possible failure to detect advanced scoring would be eliminated

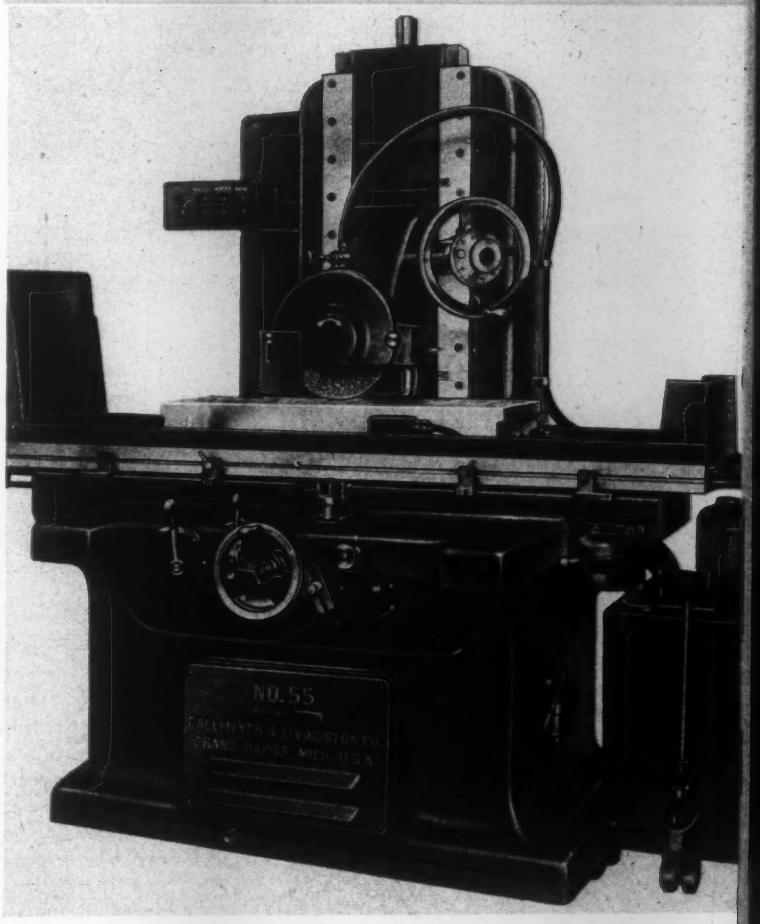
workpiece, instead of under it, *Fig.* 14. This might make it unnecessary to cover ways for protection, a practice that may result in advanced damage before routine inspection reveals scoring. In any event, chip pans should be easy to clean, and elementary as it may sound, should be *generously sloped* for drainage.

Separate coolant sumps are favored where they can be applied. *Fig.* 15 shows an easily maintained design. *Fig.* 16, rather common to many machines, is an example of inaccessible construction. Although separate sumps may be frowned upon by the exponents of "streamlined" design, it should be remembered that a machine lives an earthbound, stationary life in intimate contact with people. Cleanliness and serviceability should not be secondary to appearance.

Much thought must be given to the design of machines to enable the operators to load and unload them without undue exertion or hazard. It appears that ready solutions have been found for the complicated handling problems. Yet, some of the simple ones have been neglected. An example is the common hand-operated arbor press, *Fig.* 17. Although much of its work requires pressing shafts out of disks, it is usually so arranged that the shaft drops out, endangering the operator's feet. Loading it is also awkward since the over-hanging C-frame complicates the use of lifting equipment on heavy parts.

Within the author's experience in a single large plant, five serious finger accidents were caused when heavy tools dropped out of drill press spindles. Obviously, a retaining device is required. Yet, the manufacturers naively say that *if* the tool shanks and *if* the spindle tapers are in good condition, and *if* the tool is properly inserted, no lock is needed. When a list of "if's" is the best that can be done for a man with a mashed finger, faith in our ingenuity

Fig. 15—Below—Separate coolant sumps should be employed wherever possible



is misplaced. Although radial drill-press spindles are often fitted with draw keys, such keys are cumbersome. It is time that better drill-press spindle ends be developed, from the standpoints of both tool retention and torque capacity.

Machines should be arranged so that no spindle creep can occur when the clutch is in the neutral position. On many machines, the neutral is precariously established only after "playing" with forward and reverse directions.

Small high-speed grinders, such as the popular double-end carbide type are so quiet in operation that operators may not realize they are running. A pilot light is not the answer, because the machines coast a long time. Since they are almost universally used on alternating current, perhaps a stroboscopic effect could be created to clearly show motion.

All machines should have a standardized pad for machine serial number and other related information. This pad should be in an accessible spot for rapid perusal. Perhaps there would then be little need for step ladders, flashlights, mirrors, and grease scrapers in finding and reading serial or machine tool numbers.

The nature of work at Allis-Chalmers is such that both alternating and direct current are used in a wide range of voltages. As a consequence, it has been necessary to standardize on certain types of receptacles and plugs for specified current characteristics. Incoming machine tools, however, are naturally often out of step with these private "standards." As an example, a certain three-prong receptacle in the plant means 110-volt single-phase current, with one prong used for the grounding lead. An optical form grinding machine employing a detachable wheel head was recently delivered with an identical three-prong receptacle, internally wired for 440-volt 3-phase power. Serious burns or loss of life can easily result from such serious disagreements of standards. It is believed that the industries involved must work out plug and receptacle standards which will not interfere unduly with the design freedom of individual manufacturers but yet assure that hazardous combinations cannot be assembled.

When a machine accessory, such as a d-c chuck or a grinding head, is freely removable and connected through a plug and receptacle, it should be grounded through a ground lead in the plug-in arrangement. The obvious purpose is to eliminate shock hazard when the device is lifted from its "grounding" machine pad.

At Allis-Chalmers, 110-volt control circuits are generally required, with control current supplied by built-in transformers. Voltage at the push button stations is limited for obvious reasons—and the built-in transformer is preferred so that a single disconnect switch will definitely de-energize the entire machine. Another preference is for dust-tight fan or blower-cooled motors on machines exposed to or creating cast-iron dust, with control enclosures similarily arranged.

Although the potential hazard is clear, manual-type starters are found on machines that are inherently dangerous in the event of accidental starting. Obviously, only magnetic starters which drop out and stay out after power failure should be used on such machines.

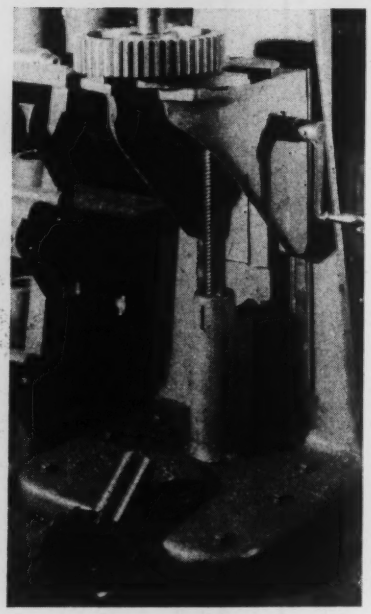


Fig. 16 — Above — Built-in sumps are often inaccessible—and neglected

Fig. 17—Left—Hand-operated arbor press, though time-honored, is inherently unsafe. Operator's feet are endangered by the dropping shaft and loading is awkward because of the over-hanging construction

Centralized Power Control Essential

From the point of view of safe maintenance, there remains for each plant management the task of establishing a single location at which all forms of power can be disconnected from the machine and locked. Usually, a simple disconnect switch and personal padlock for each maintenance man serves the purpose. In more complex machines, more elaborate precautions may be required. In any event, shutdown procedure must be clear—and enforced.

In conclusion, it is admitted that it is easy to criticize the endeavors of others. When unhampered by practical consideration, uninhibited imagination can conjure up visions of tomorrow's machines—so productive, so convenient, so trouble-free and safe, that there would be nothing left to talk about. Such machines are the ultimate goal. Toward it, builders and users have made substantial strides. In the interim, however, there is much left to talk about.

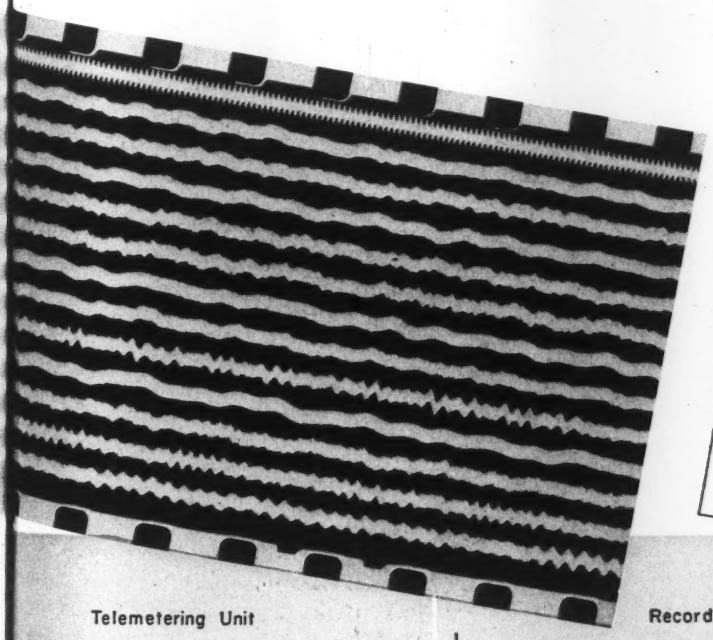
The author acknowledges the helpful co-operation of the following companies in furnishing illustrations for this article:

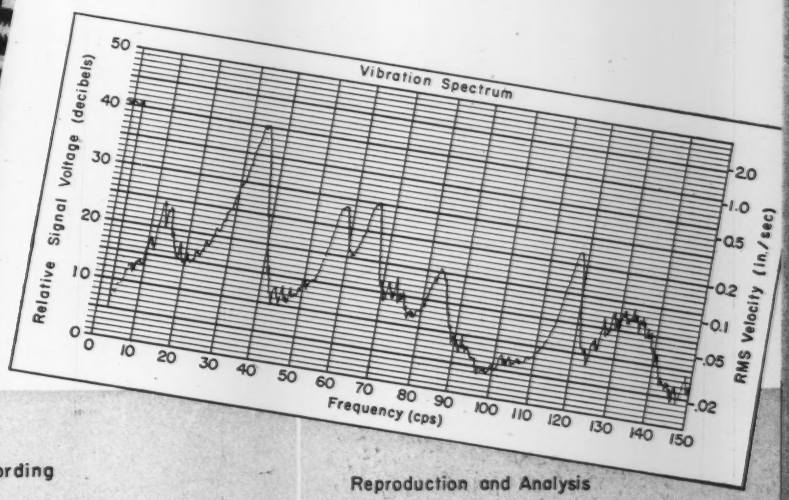
Cadillac Gage Co. (*Fig.* 13) ..... Detroit
Gallmeyer & Livingston Co. (*Fig.* 15) Grand Rapids, Mich.
Ingersoll Milling Machine Co. (*Fig.* 12) .... Rockford, Ill.
Kearney & Trecker Corp. (*Fig.* 11) ..... Milwaukee
Niles Tool Works (*Fig.* 9) ..... Hamilton, Ohio
Sundstrand Co. (*Fig.* 4) ..... Rockford, Ill.

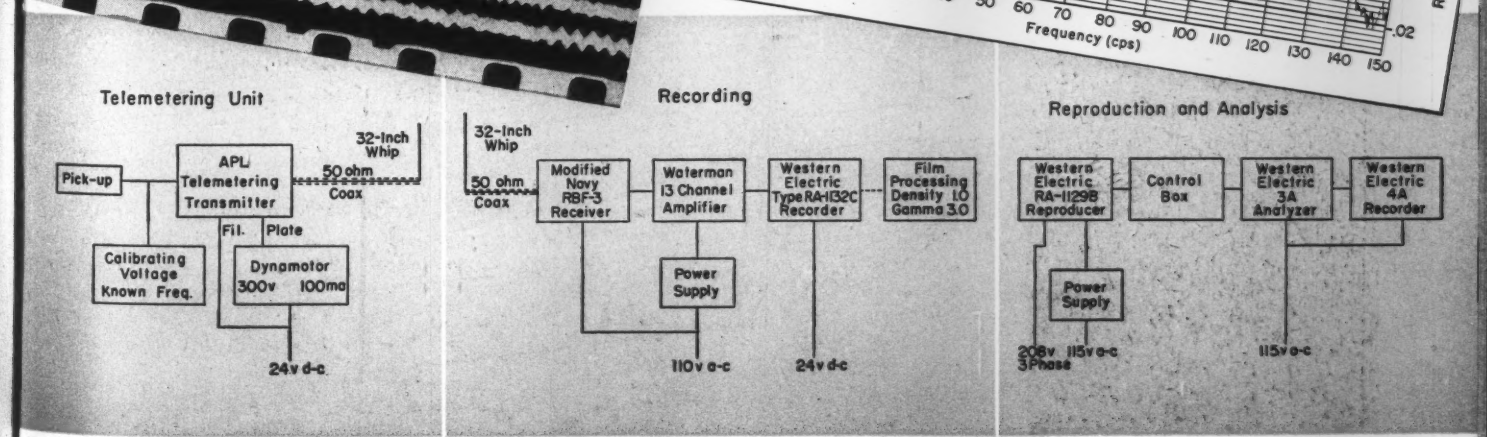
SCANNING the Field For Ideas

Telemetered vibration data, gathered from inaccessible locations on fighter and conventional aircraft for example, may be recorded and analyzed into useful form with a minimum of effort by using the system illustrated below. Developed by C. B. Cunningham, Applied Mathematics Branch, Mechanics Division, Naval Research Laboratory, the system converts vibration into an electrical signal. A velocity type pickup is employed because it has a low-impedance output sufficiently large to modulate a telemetering transmitter without any associated amplifiers or oscillators. Output from the pick-up is fed to a telemetering transmitter operating at 85 megacycles. With a 32-inch whip antenna and 24-volt supply from the plane's battery, reliable operating ranges of 50 miles with a plane altitude of 3000 feet are normal.

Recording of vibration data is also shown by a block diagram wherein the frequency-modulated telemetered signal is received by a modified Navy type RBF-3 receiver. The output from this discriminator is fed to at least four channels of a multichannel amplifier whose output is then fed to an equal number of recording channels of a Western Electric Mirragraph recorder. Each amplifier is set at a different gain level so that the vibration signal will be within the dynamic range of the recording equipment, which is essentially 13 sound channels recording on 35 millimeter film. The signal voltage is







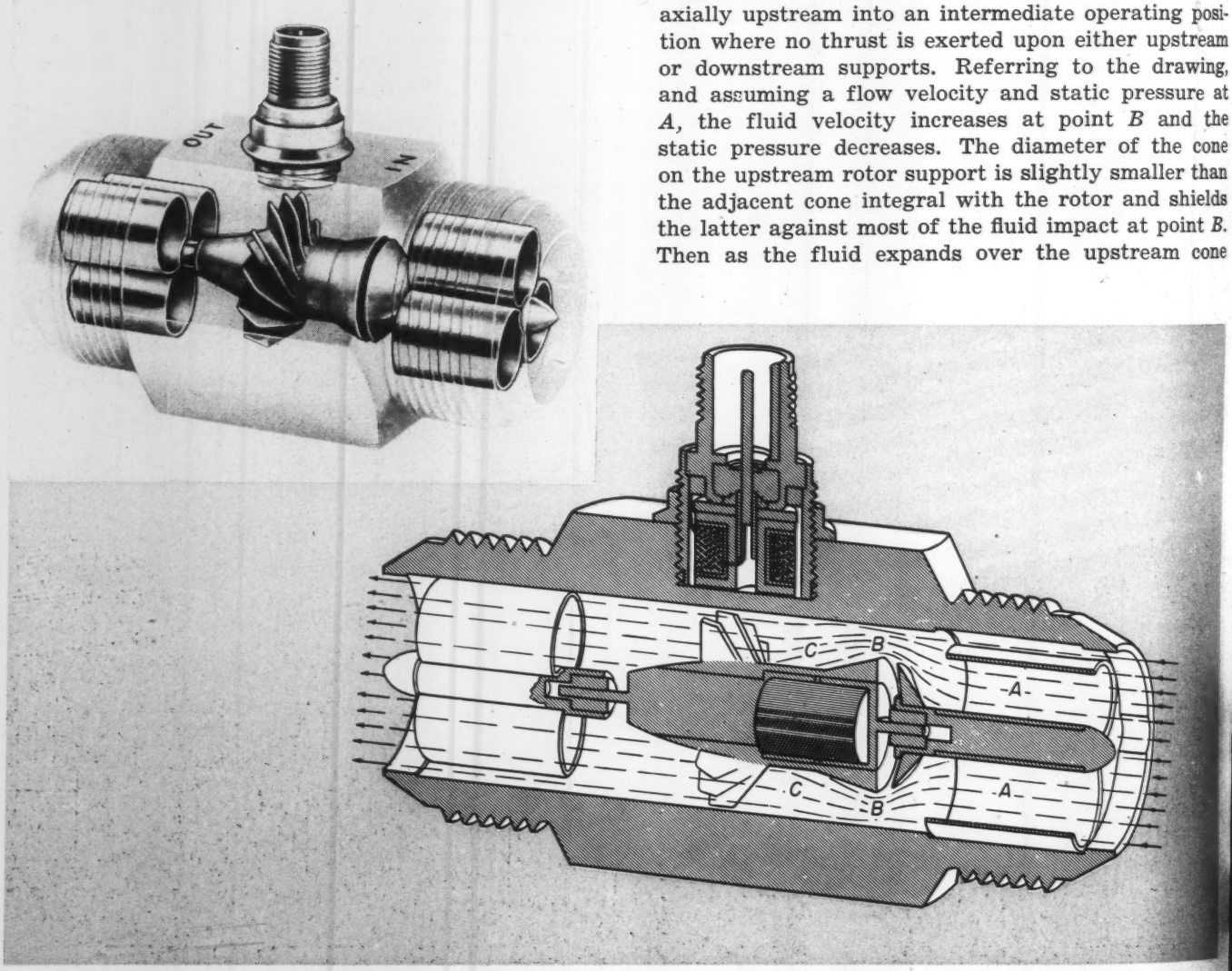
applied to a flat galvanometer ribbon which is displaced laterally. A shadow of this ribbon is projected through a narrow lateral slit on the moving film.

The block diagram for reproduction and analysis shows equipment for graphing a vibration spectrum from the film made in the recording section. A selected section of film is made into a loop and put into the reproducer which scans one-half of each trace photoelectrically through a narrow slit so that in effect the film is a variable area recording. Output from the reproducer is an electrical signal whose amplitude and frequency characteristics are similar to the original signal fed to the telemetering transmitter. The recording of a known input to the telemetering transmitter permits calibration of the system so that exact signal levels may be determined. Reproduced signals are fed through a frequency analyzer to a recorder which plots the output level in decibels against frequency.

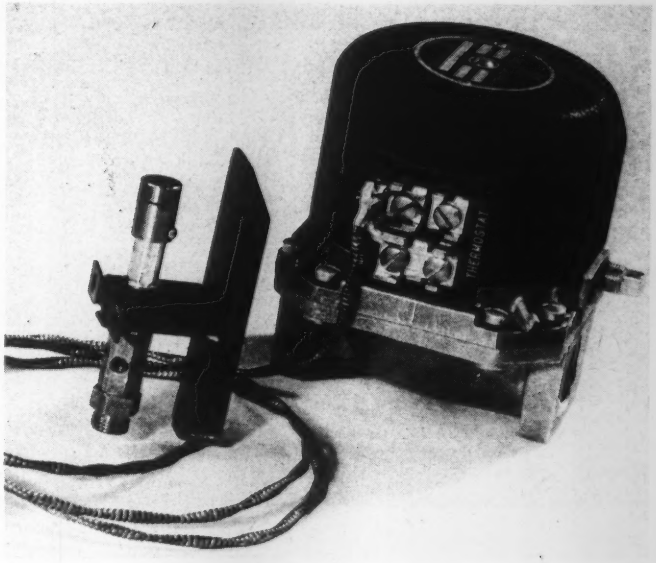
Frequency response of the entire system is flat within one decibel from 3 to 5000 cycles per second. Frequencies may be determined to an accuracy of 3 per cent and amplitudes within 10 per cent. For vibration measurements frequency response is, for all practical purposes, limited by the vibration pick-up to a range of 5 to 1000 cps. Shown is a typical film recording of thirteen channels and a vibration spectrum obtained from the analyzer for a radar antenna reflector mounted under a single-engined aircraft, showing the maximum vibration amplitude occurring at this location during normal flight.

Electronic flowmeter, below, incorporates a novel, high-efficiency sensing rotor which spins freely within a venturi. Designed by the Potter Aeronautical Co., the new design eliminates undesirable features such as bearing maintenance, friction drag and high-pressure drop. The flow sensing rotor is dynamically balanced and contains a magnet to excite an external pick-up coil connected to an electronic instrument for measuring the flow. Speed of the rotor is determined by the velocity of the fluid passing through the housing and by the pitch of the rotor blades.

Fluid flow around the rotor establishes upstream thrust components which exceed the downstream drag factor. This tends to move the revolving rotor axially upstream into an intermediate operating position where no thrust is exerted upon either upstream or downstream supports. Referring to the drawing, and assuming a flow velocity and static pressure at *A*, the fluid velocity increases at point *B* and the static pressure decreases. The diameter of the cone on the upstream rotor support is slightly smaller than the adjacent cone integral with the rotor and shields the latter against most of the fluid impact at point *B*. Then as the fluid expands over the upstream cone



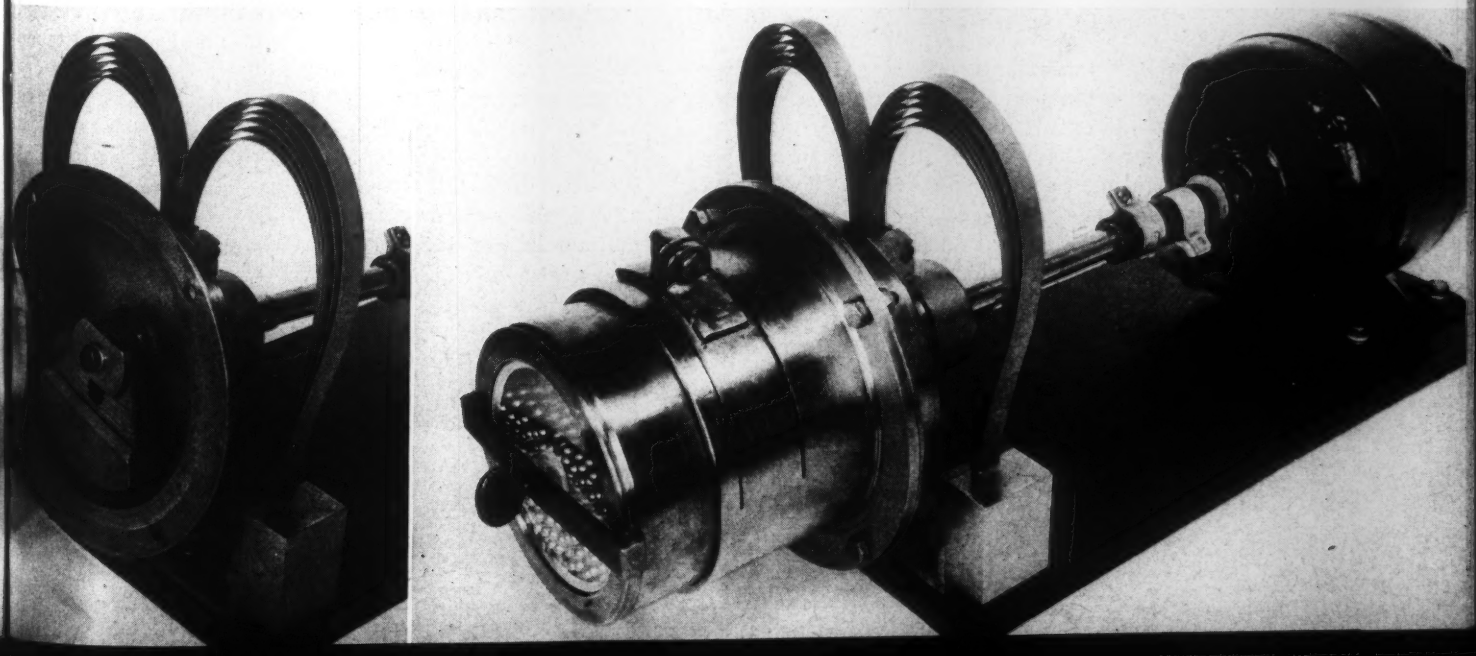
of the rotor at point *C*, the velocity decreases and the pressure increases to almost the same value as at *A*. Therefore there will be a net thrust in the upstream direction. Because the rotor reaches a balanced position, no thrust bearings are needed and a small-diameter rotor shaft and short guide bearings are employed. With no loading of the blades on the rotor, the pressure drop is directly related to venturi efficiency which can be made high.

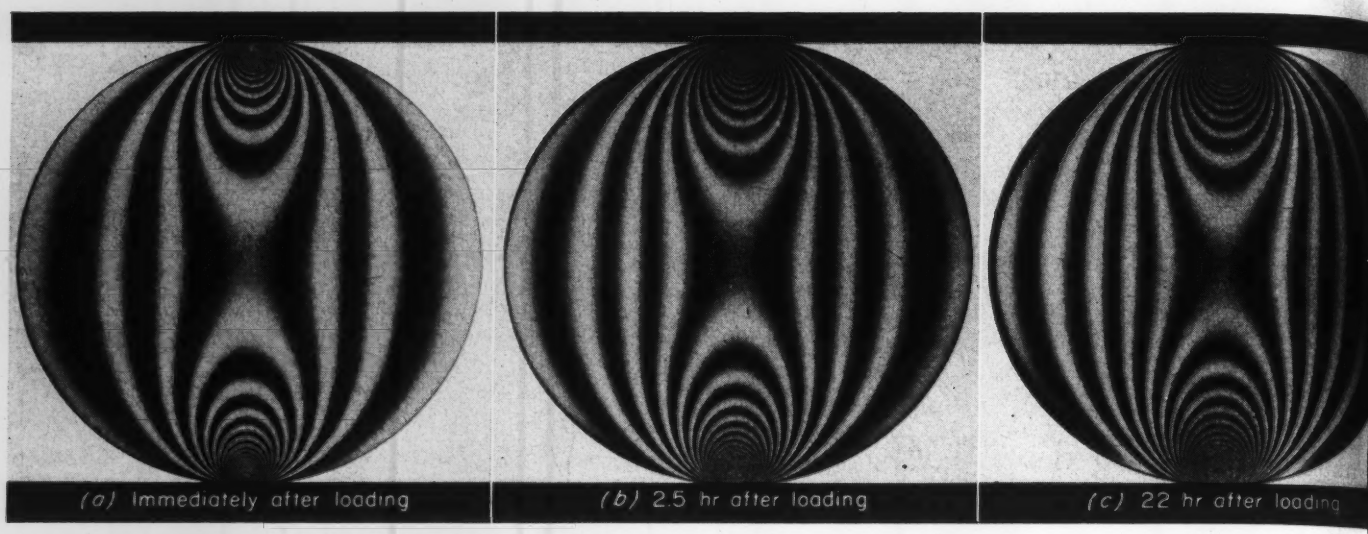


Self-powered automatic control, right, for gas-fired heating plants generates its own electricity to operate the relay-controlled diaphragm valve illustrated. This control system, developed by Minneapolis-Honeywell Regulator Co., is based on the principle of current generation when two unlike metals, joined at one end, are heated. The Powerpile employs 25 such thermocouples and generates 400 to 500 millivolts although the system will operate safely on an output as low as 200 millivolts. The thermostat used in the system is bellows-actuated and uses a mercury switch to eliminate the possibility of dust or oxidation impairing the efficiency of the thermostat. A self-contained polarized relay is employed in the valve for added power. A pilot burner is utilized in the system and, in case of gas supply failure, the entire system shuts down automatically.

Vibratory ball mill, below, developed at the National Bureau of Standards rapidly and uniformly grinds cotton into particles a few microns in length with little or no oxidative change or contamination of the cellulose. In view of the fact that the mill produces a uniform powder and is more efficient than previous devices it is expected to be useful for grinding and blending substances such as pigments, ceramic materials, metal powders, resins, and animal tissues. In this mill a cylindrical jar, suspended by leaf springs, contains steel balls in contact with the material to be ground. The jar is swung through a circular path while being rotated slowly. Motion of the jar is produced by a horizontal shaft connected to a motor at one end and an eccentric weight at the other. Rotating at a speed of 1800 rpm, the weight drives the weight housing in a circular path that is confined within certain limits by the flexural resistance of the springs. The jar containing the sample is held in a cylindrical holder which is attached to the weight housing by a greased slip ring. A small difference in diameter between the flange of the jar holder and the slip ring groove permits the holder with the clamped-in jar to be rolled around the groove circumference by centrifugal force. This rotation takes place at a rate of about 4 rpm in a direction opposite to that of the rotating weight.

In experiments the mill reduced 5 grams of cotton in 30 minutes to particles 10 microns or less in major dimension. X-ray diffraction measurements showed that the cellulose was converted almost completely to the amorphous form.





Three-Dimensional Photoelasticity

. . . new creeping method overcomes limitations of conventional freezing technique

By A. J. Durelli and R. L. Lake
Research Engineers
Armour Research Foundation
Chicago, Ill.

CREEP in plastics is being utilized in a new method of studying distribution of stresses and is promising to be an extremely useful tool for the stress analyst. The common way of studying three-dimensional states of stress by means of photoelasticity is to "freeze" the stresses in a plastic model. Essentially this freezing method requires that the loaded model be heated to about 200 F for several hours. The temperature is then reduced slowly and the model unloaded and sliced. Each slice shows a permanent photoelastic effect, corresponding to the elastic distribution of stresses which was present in the model when loaded. This conventional method has several limitations, the two most important being the need of an oven with precise temperature controls and the large permanent change of shape of the model during heating. The latter occurs because the moduli of elasticity of the plastics used decrease at high temperatures much faster than their optical sensitivities increase.

Freedom from mechanical and optical creep has long been one of the specifications of a good photoelastic material. Research conducted at Armour Research Foundation last year on the creep nature of some photoelastic materials shows, however, that creep when properly used may be an advantage instead of a shortcoming.

The material studied was Catalin, a water-clear transparent phenol-formaldehyde casting resin. In Catalin, at room temperature and stresses up to about 1000 psi (tests have not yet been carried beyond this limit), optical creep is linearly proportional to stress. The importance of this simple optical creep law may be appreciated by looking at *Fig.* 1, where fringe patterns of a disk under diametral compression are shown. The first photograph was taken immediately after the disk was loaded, and subsequent ones at different intervals after loading. The last photograph shows the stress pattern, due to creep, which remained in the disk after the load had been removed. The graph in *Fig.* 2 shows the change in fringe order (maximum shear) for points on the horizontal axis of the disk, as a function of time. Everything happens as if the only thing that changed with time was the fringe value or optical sensitivity of the material. Despite creep, all fringe patterns, including

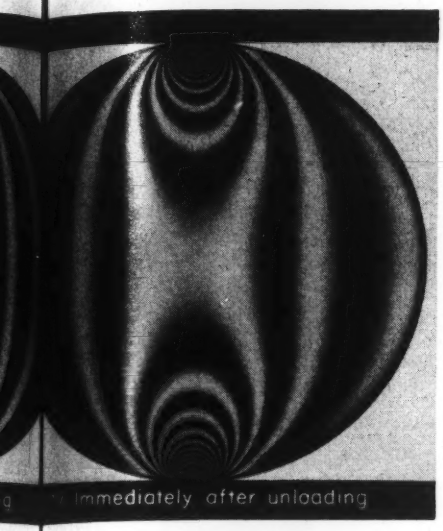


Fig. 1—Above—Effect of time on photoelastic fringe patterns in a Catalin disk under constant load. Residual stress due to creep when model is unloaded is also shown

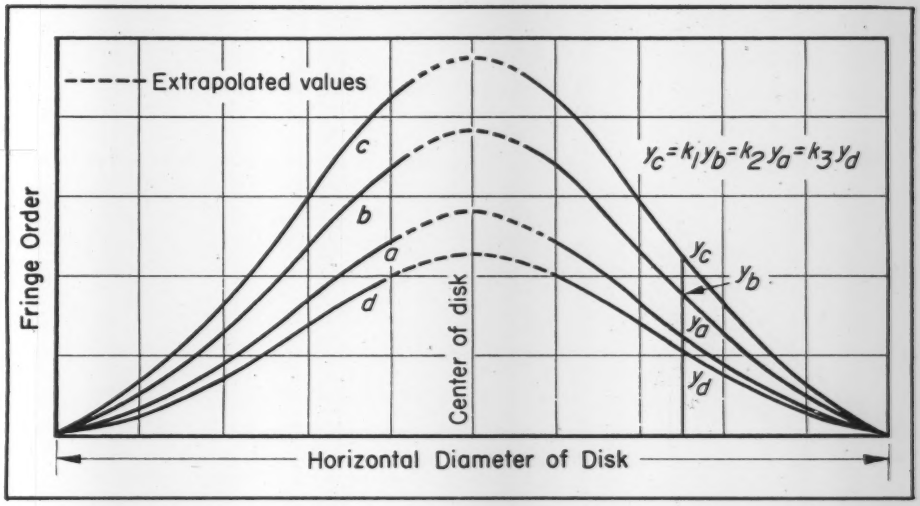


Fig. 2 — Above Right — Creep in Catalin under constant load. The fringe value or optical sensitivity changes but is a function of time only. Curve (a) is for fringe order of disk in Fig. 1 immediately after loading; curve (b) for 2.5 hr after loading; curve (c) for 22 hr after loading; curve (d) for immediately after unloading

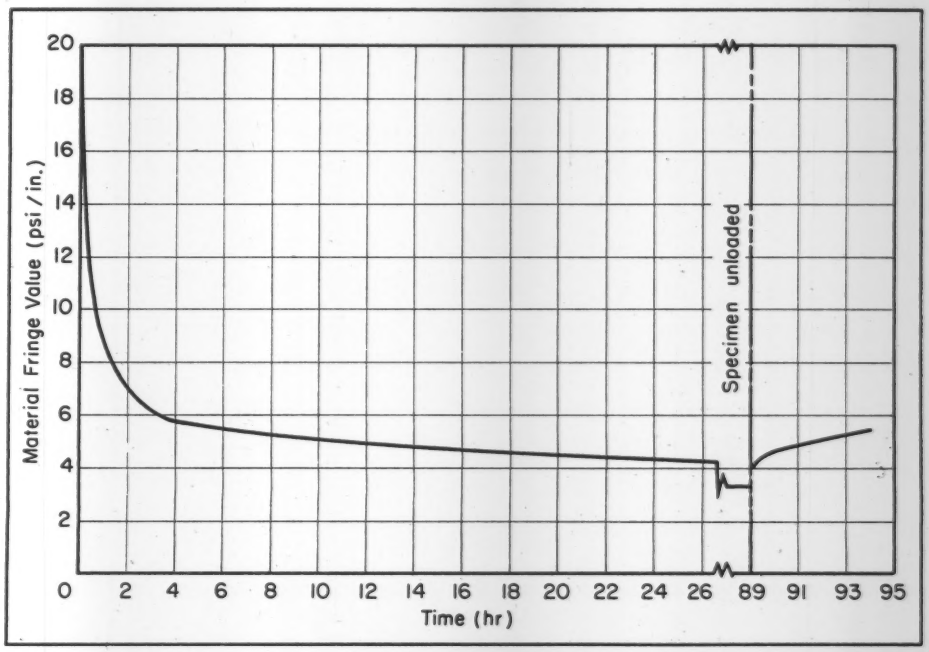


Fig. 3—Right—Fringe value as a function of time for Catalin under constant load

Fig. 4—Right Below—Cylindrical shaft with deep hyperbolic notch under pure tension

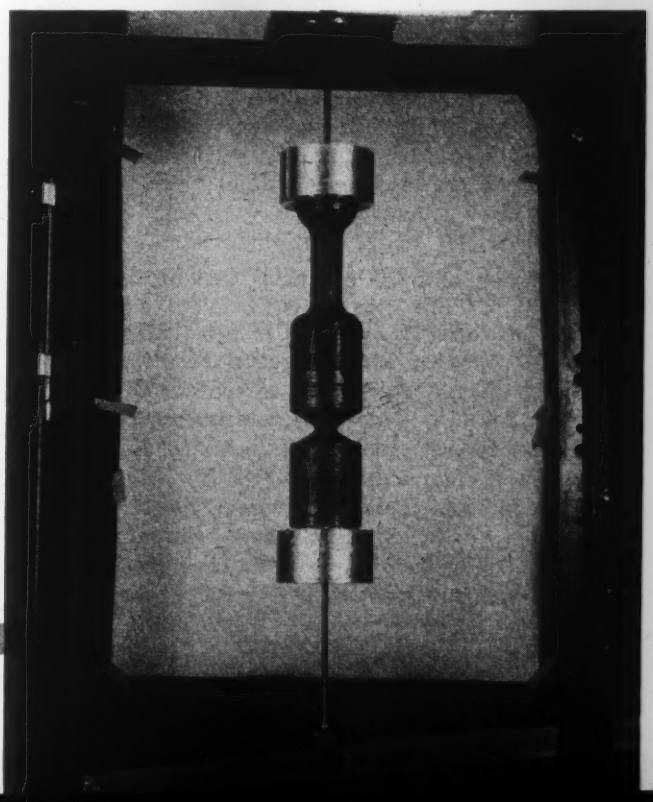
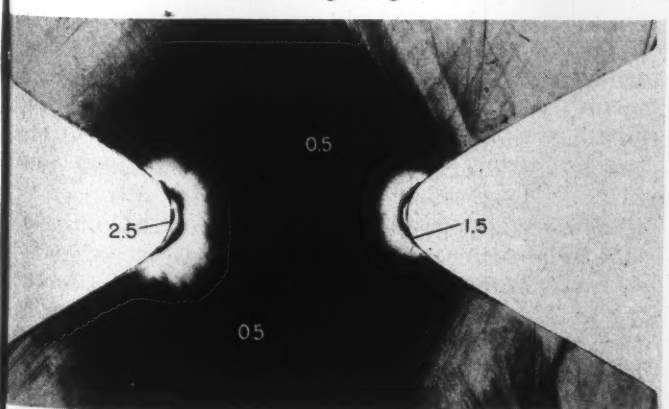


Fig. 5—Below—Light field isochromatic pattern of axial slice, showing fringe order



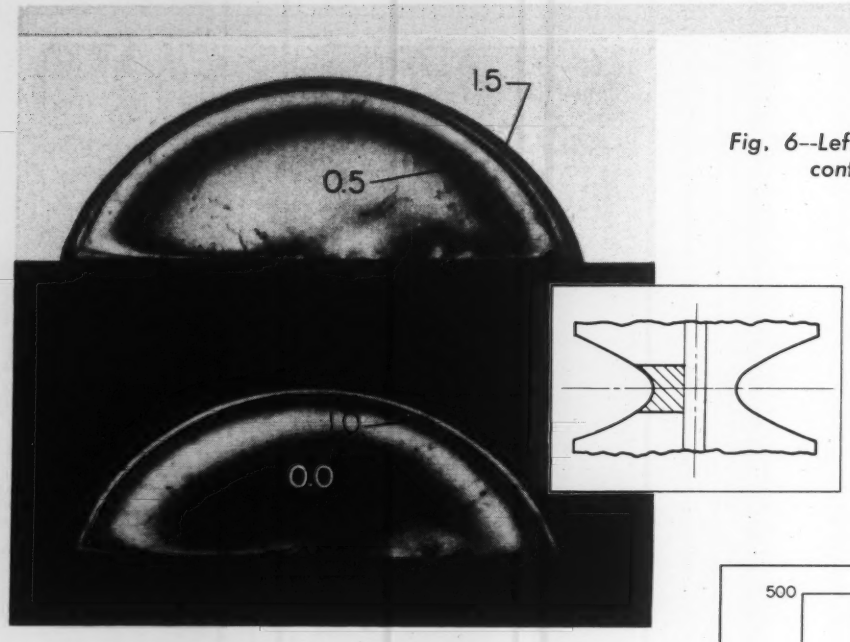
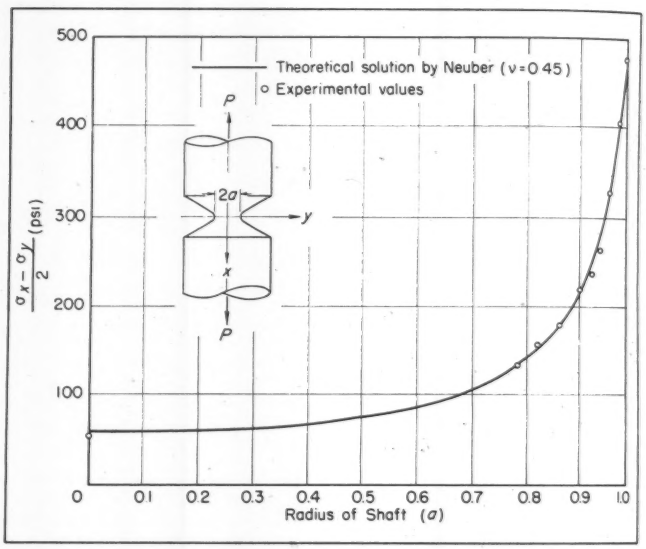


Fig. 6--Left—Isochromatic patterns of a portion of slice containing transverse section of symmetry

Fig. 7—Below—Maximum shear stress, ½ ($\sigma_x - \sigma_y$) for transverse section of symmetry of a circular shaft with a deep hyperbolic notch under pure tension



the last one, correspond to an elastic distribution of stresses.

This remarkable property can be used to advantage in two-dimensional photoelasticity, as a means of increasing the optical sensitivity of the material, as long as the correct fringe value is used to interpret the picture. When the material does not creep, the fringe value is constant. When the material creeps, the fringe value is a function of time, *Fig.* 3.

Usually it is not neecessary to know the fringe value of the material because computations can be made by taking as standard a point in the model where the stress is known. The stresses are given then in ratio form as nondimensional factors, indicating stress distribution.

The extent and permanence of the residual patterns remaining in the disks discussed, *Fig.* 1, suggested the possibility of substituting a period of loading at room temperature for the usual stress-freezing technique which involves cooling under load. Such a method, if proved satisfactory, would eliminate the need for a large oven with precise temperature control and would require no more time than the conventional technique, because the time under load at room temperature would be no longer than the time required for cooling a model from its critical temperature.

Agrees with Theoretical Calculations

To check the validity of the new method a cylindrical shaft with a deep circumferential notch of hyperbolic form, subjected to pure tension, was chosen. Both the theoretical solution of H. Neuber[1] and the photoelastic solutions of M. M. Leven[2] were available for comparison.

The model was machined from a block of Catalin 4 by 4 by 18 inches which had been annealed by holding at 165 F for 4 hours and cooling slowly. Its general form is apparent in *Fig.* 4 which shows it under load. Machining was done at a relatively low speed since the model had a tendency to sag under its own weight when the lathe was stopped and the resulting unbalance produced severe whipping at high speed. All machining cuts were 0.010-inch or less. The notch profile was obtained by machining to a template and consequently could not be held to the exact mathematical shape intended. The a/ρ ratio of the finished notch (where a is the radius of the section and ρ is the radius of curvature at the root of the notch) was found to be 3.9 rather than 4. The cylindrical reduced section was included for the purpose of obtaining an autocalibration. The load which totaled 383 pounds was applied for five hours through threaded caps containing ball joints.

Slicing was done with a wet cutoff wheel mounted on a large surface grinder. The light field pattern of the axial slice is shown in *Fig.* 5 while one section of the transverse slice through the root of the notch is shown in *Fig.* 6. The thickness of the axial slice in *Fig.* 5 was 0.031-inch at the root of the upper notch and 0.046-inch at the root of the lower notch. A certain amount of bending occurred while the model was being sliced, and it was necessary to elim-

[1] References are tabulated at end of article.

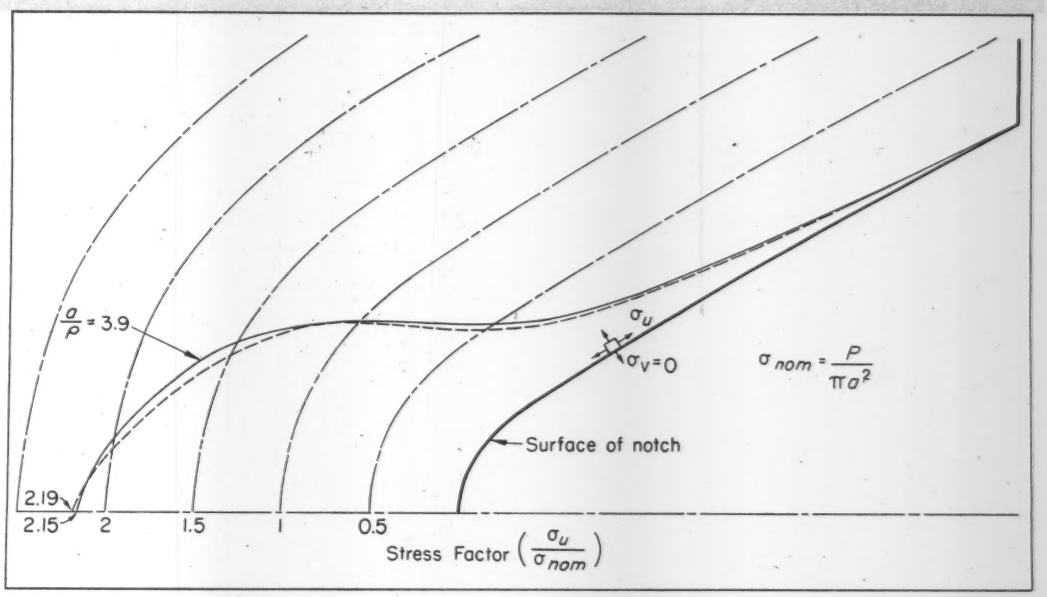
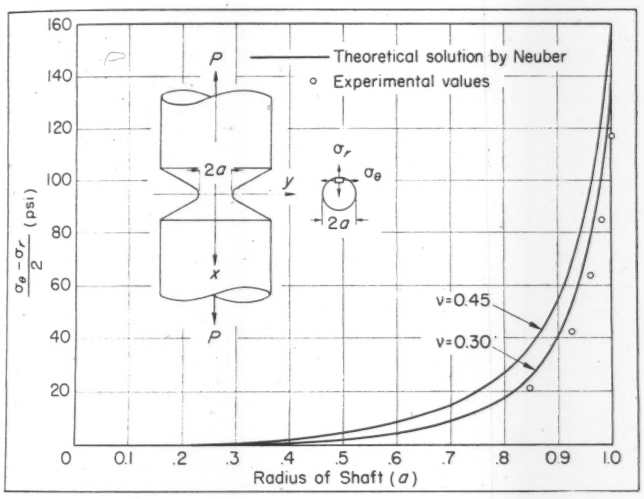


Fig. 8—Right — Distribution of stress σ_u along the surface of notch in circular shaft under pure tension

Fig. 9 — Below — Shear stress, $\frac{1}{2}(\sigma_\theta - \sigma_r)$ for transverse section of symmetry



inate bending stress from the computation by averaging the results of the two sides of the slice. The average value of stress at the root of the notch was found to be 2.19 times the nominal stress on the reduced section as compared with a theoretical concentration factor of 2.15 for a notch with an a/ρ ratio of 3.9. Other examples of agreement with the theoretical values are shown in *Figs.* 7 and 8. It will be noted that the experimental values are always within 10 per cent of the theoretical ones. In those cases where the disagreement is greater than 5 per cent the absolute errors are small. There is little doubt that more experience in slicing large models will permit improvement in the attainable precision.

Experimental stress distribution in the transverse plane at the root of the notch together with the corresponding theoretical distributions computed for two values of Poisson's ratios are showing in *Fig.* 9. The lack of agreement probably can be explained in a large measure by the fact that the slice used was 0.154-inch thick. Both the magnitude and direction of the principal stresses change in such a way that the mean shear stress through the slice is less than the value in the central plane. This figure also illustrates a point which some photoelasticians are prone to forget; namely, the possible strong dependence of stress on the elastic constants in three-dimensional problems. Here the shear stress at $0.7a$ increases almost 70 per cent when Poisson's ratio, ν, increases from 0.3 to 0.45. At the surface the percentage increase is down to 17.5 which is still important.

It is believed that this data is sufficient to demonstrate the validity of the creep-freezing method for those cases in which boundary conditions do not change during the course of the test. The technique is certainly not complete as yet. It is necessary to make a further study of calibration techniques since the autocalibration method may not be as practicable in many three-dimensional cases as it is in two dimensions.

BIBLIOGRAPHY

1. H. Neuber—*Kerbspannungslehre,* Springer Verlag, 1937. Berlin. (*Theory of Notch Stresses,* Translation No. 74, The David Taylor Model Basin).
2. M. M. Leven—"A New Material for Three-Demensional Photoelasticity", *Proceedings SESA,* Vol. VI, No. 1

"In scanning the available means to reduce costs—an essential step if markets are to be broadened during the coming year—it appears there is still room for improvement in direct productivity, but from now on research and development will play an increasingly important role in effecting greater distribution of product within the framework of our national wealth. The competition in research and development may prove to be a sad eye-opening experience for those firms still under the impression that they have adequate research departments simply because the name research is printed on the door. Companies in which research is a vital part of management planning are the ones most likely to expand and prosper, the others may experience difficulty in maintaining healthy growth"—W. S. RICHARDSON, *president, B. F. Goodrich Chemical Co.*

Systematic Design of Mechanisms

By H. Ziebolz
Vice President, Engineering
Askania Regulator Co.
Chicago, Illinois

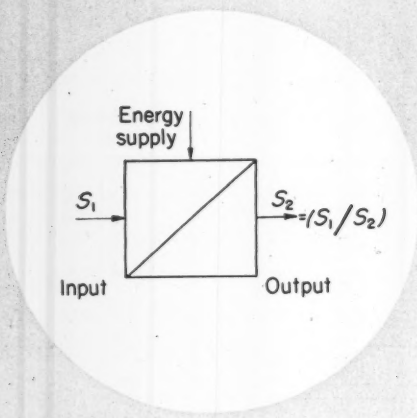


Fig. 1—Any mechanism may be represented by block symbols. In this block, auxiliary power amplifies an input to give the desired output

IN GENERAL, any mechanism may be considered as a "translator" with a certain input and a corresponding output. This design concept was discussed in a previous series of article[1, 2, 3]. Likewise, any physical parameter can be used as an input and any or the same parameter as the output. At that time symbols were established to identify such translators, *Fig.* 1, and a general reference "translator map" was drawn to be used as a filing or reference system for parameters frequently encountered in the design of mechanisms, *Fig.* 2.

In working with these concepts it was soon found that there was a need for an additional group of symbols to represent special types of translators. This type of translator or mechanism has two or more inputs subject to a modification through the device which produces an output representing a mathematical operation performed on and with the inputs. Such a translator is called an "operator" for the purpose of this analysis.

As an example, a lever, a mass or a scale subject to a number of forces acting upon it produces an output, i.e., a force or an indication which is the sum total of all the force inputs. Such an operator performs the function of summarization and is called a summarizer. Other mathematical operations are performed by means of other operators.

In order to systematize the approach, a map similar to that for the translators can be drawn to establish a definite reference place for any particular operator as shown in *Fig.* 3. Each operator is assigned an arbitrary letter and every parameter a subscript numeral. Thus F_3 is the map designation for a force splitter. In *Fig.* 4 are tabulated each of these operators, showing their mathematical functions and corresponding symbols which are to be used in a block diagram describing any device in question. *Fig.* 4 appears to be self-explanatory with the exception perhaps of the last column which introduces the concept of a "splitter".

A splitter is an operator which has one input parameter and several output parameters representing the *same* variable of the same magnitude or of any fixed ratio to the input. A typical example of such

SYSTEMATIC DESIGN aids the designer in developing or analyzing any mechanism in terms of operation or function. This fundamental approach simplifies and organizes the designer's work like a schematic diagram aids an electrical engineer. It catalogs all known mechanisms for ready reference and provides for future devices to be developed. By such a systematic study a designer can substitute equivalent mechanisms, obtaining more suitable characteristics, greater accuracy, more dependable operation, or lower cost

[1]References are listed at end of article.

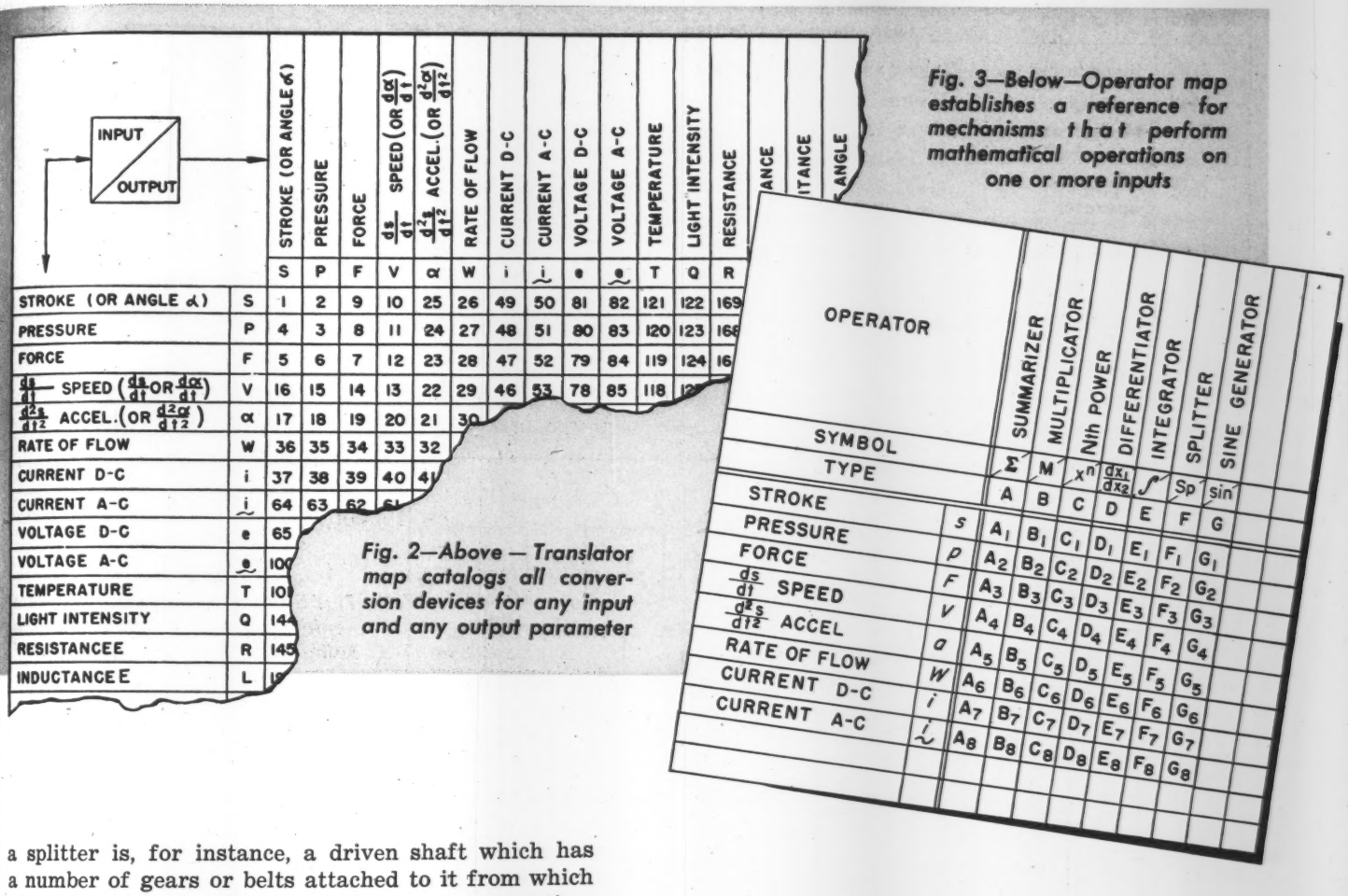


Fig. 2—Above — Translator map catalogs all conversion devices for any input and any output parameter

Fig. 3—Below—Operator map establishes a reference for mechanisms that perform mathematical operations on one or more inputs

a splitter is, for instance, a driven shaft which has a number of gears or belts attached to it from which other devices are deriving their power or motion, *Fig.* 5. Another example is a pressure header which has a number of outlets.

One can think of a splitter best as a device which permits the branching of parallel circuit elements. Series operation of translators on the other hand are indicated by a chain arrangement of individual blocks connected by plus signs.

With these symbols and concepts, it is possible to describe any desired circuit or mechanism. In *Fig.* 6, for instance, a device is shown which is an overall translator (x_1/x_2) with an input x_1 and an output x_2. The input x_1 is first subdivided or split into two branches, x_3 and x_4. Further the first output x_3 is multiplied by means of a multiplicator M, then twice integrated through a series circuit. This output is added to x_4 and to the rate component of x_2. The important feature of this symbolic block diagram is the fact that it not only gives the overall circuit, but also the operation or function of each component.

In order to avoid the necessity of drawing a circuit as shown in *Fig.* 6, it is possible to describe this same circuit by the following pseudo equations:

$$\mathrm{Sp}(x_1/x_3, x_4) + \mathrm{M}(cx_3) + \int(x_5 dt) + \int(x_6 dt) +$$

$$\Sigma(x_8, x_7, x_4/x_9) + \mathrm{Sp}(x_9/x_2, x_{10}) = (x_1/x_2)$$

$$(dx_{10}/dt/x_7) = (x_{10}/x_7)$$

At this point it appears desirable to give some typical examples of operators. Surveys show that certain operations can be performed more easily with certain types of parameters than with others. For instance, there are a number of devices available for summarization[4]. On the other hand, there is so far no device or operator known which permits direct summarization of pressures. Absence of such a device forces the designer to first translate pressures into other parameters for which summarizers are available—forces, voltages, currents, etc.

Types of Operators

SUMMARIZERS: In surveying summarizers it is logical to start with mechanical devices, the oldest known to man. The earliest summarizer of forces most likely is the scale or lever which needs no further explanation, *Fig.* 7. For the summarization of strokes the same lever can be used with the addition of multiple links, *Figs.* 8, and 8*a*.

For summarizing rotary motion differential gears of various designs are used. The one shown in *Fig.* 9 is of interest because it uses a new development in gear design. It permits the elimination of the conventional bevel gear spider, thereby reducing backlash to an adjustable minimum. In *Fig.* 10 the summarization of strokes s_1 and s_2 produces a corresponding pulley movement s_3 which is the sum of s_1 and s_2. Another often used summarizer for mechanical displacements (angular rotation) is a differential screw in which one motion is introduced into a screw while the second rotation is produced by moving the nut

Operator	Function	Mathematical operation	Symbol	
			Written	Block
A	Summarizer	$\Sigma(x_1+x_2+x_3+\ldots\ldots x_n)$	Σ	Σ
B	Multiplicator	$x_1 x_2 x_3 \ldots\ldots x_n$	M	M
C	Nth power operator	x^n	X^n	X^n
D	Differentiator	$\frac{dx_1}{dx_2}$	$\frac{dx_1}{dx_2}$	$\frac{dx_1}{dx_2}$
E	Integrator	$\int x_1 dx_2$	$\int$	$\int$
F	Splitter	$ax_1=x_2;\ bx_1=x_3;\ nx_1=x_n$	Sp	Sp

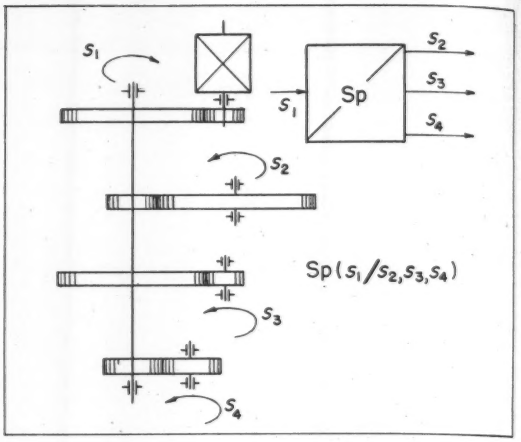


Fig. 4—Above Left—Classification of operators, showing the mathematical operation performed and the symbols representing each

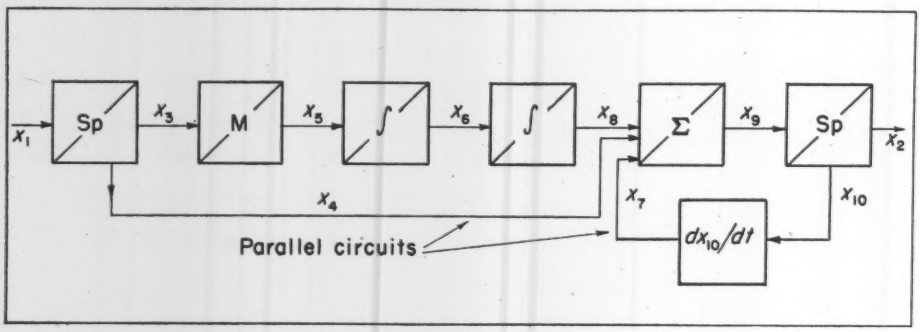


Fig. 5—Above—Conventional representation and symbols for a splitter using a motor drive and take-off gearing in parallel

Fig. 6—Left—Overall operator showing how symbols are combined to produce an output from a given input. Two splitters, one multiplicator, two integrators, one summarizer, and one differentiator are employed in the system

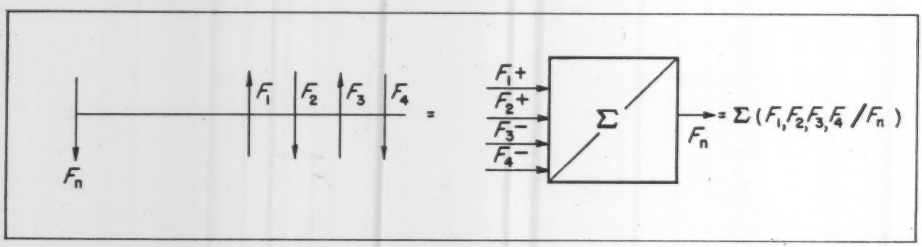


Fig. 7—Left — Diagrammatic representation of a force summarizer showing its equivalent block and written symbols

which in turn acts as a screw, *Fig.* 11.

Because of the general increase in use of electrical devices, a number of circuits have been developed for summarizing electrical signals. Most common circuits are for summarizing either voltages or currents, *Fig.* 12. In this circuit i_1, i_2, i_3, i_4 represent individual current across the corresponding resistors R_1, R_2, R_3, R_4. As all branches finally join into one branch,

$$i_t = i_1 + i_2 + i_3 + i_4 = \Sigma i_n$$

or the voltage drop of e_r across the resistor R gives an indication of the sum total of all currents. In order to use this basic circuit it is therefore necessary only to translate the individual variables into corresponding currents by means of suitable translators taken from the translator map.

In industrial control applications, a general problem involves blending or summarizing flows. Obviously, the simplest form of summarization for liquids and solids is a common duct or vessel into which these elements are delivered. In many applications, however, an indication is desired to give the sum total of all flow rates at a given moment. Because liquids usually cannot be added in such cases, it becomes necessary to translate each individual flow rate into another parameter (current, voltage, force, airflow, etc.) which can then be conventiently summarized to produce an output (signal), representing the sum total of all flow rates.

System Would Develop All Circuits

Patent literature covering devices of this type indicates that a systematic approach to the solution of this problem would have produced all of the separately patented circuits and a considerable number of additional ones[5]. As a matter of fact the analysis of these devices by the author finally led to the development of this systematic method of approach.

Obviously the applications discussed here by no means exhaust either the mechanical or electrical devices available for summarization. They are given as illustrations rather than as a reference book of ready-made solutions. Some typical or unusual examples of other types of operators will be discussed in the same manner.

MULTIPLIERS: Starting again with mechanical solutions for multipliers, *Fig.* 13 shows details of a mechanical multiplier which is visible as part of the

H. ZIEBOLZ—in charge of engineering and development of servo-mechanisms and instrumentation for Askania's industrial control division, special devices for the Armed Forces, and industrial special devices—has been active in the design of hydraulic regulators and servos for more than twenty years. During World War 2 his main efforts outside the field of controls for industry were concerned with submarine trainers for the Bureau of Ships. During a trip to Japan in 1934 he started his work on systematic design. His first paper on the subject was delivered in 1942 at the Gordon Conference of the American Association for the Advancement of Science. During the same year he published *Relay Devices and Their Application to the Solution of Mathematical Equations.* One of the original purposes of his work was to clear the way for the designer through uncertainties in the present patent situation by reducing certain aspects of so-called invention to a systematic approach

assembly of *Fig.* 10. Being an approximation, due to nonlinear displacements, it is best for small values of s_1 and s_2. A better solution is shown in *Fig.* 14 which produces an output (AB) with either A or B varying through respective ranges of ± 10.

For even higher accuracy a device is available which is based on the equations:

$$(s_1 + s_2)^2 = s_1^2 + 2s_1s_2 + s_2^2$$

$$(s_1 - s_2)^2 = s_1^2 - 2s_1s_2 + s_2^2$$

Subtracting the second from the first equation, the right-hand side becomes

$$4s_1s_2$$

The multiplicator, therefore, consists of two summarizers, two 2nd-power operators, and one additional summarizer. It can be represented in the form

$$\Sigma(s_1 + s_2/s_3) + (s_3^2/s_4) = s_5$$

$$\Sigma(s_1 - s_2/s_6) + (s_6^2/s_7) = s_8$$

$$\Sigma(s_5 - s_8/s_9) = (4\, s_1\, s_2)$$

Its remarkable accuracy of 1 in 10,000 with linearity throughout the range makes this device ideal for precision computers. Incidentally, the same principle is used in electronic analog computing circuits to produce the product of two currents or voltages. Other forms of multiplicators translate the variables first into logarithms, summarize as the next step and then reconvert into antilogarithms to produce the product of the inputs.

Division, i.e., the reverse operation, is more difficult in most cases. An interesting solution of a device which uses a servo circuit for division is schematically shown in *Fig.* 15. The equation solved by this device is:

$$s_3 = \frac{s_2}{s_1}$$

In order to obtain this result the first multiplicator has as input s_1 and the unknown result s_3.

Its output is therefore s_1s_3 and is used as one of the inputs of the summarizer whose other input with negative sign is the value of s_2. The summarizer acts as a servo and adjusts itself automatically in such a way that its output is always zero, so that

$$s_1s_3 - s_2 = 0;\ s_3 = \frac{s_2}{s_1}$$

Unfortunately, the problem of division becomes more and more difficult as the denominator approaches zero or as s_2 and s_1 become smaller and smaller.

In the first case, the output becomes infinite which obviously is impractical as the range of computers is limited; in the second case, the device approaches its own noise level or the range of its backlash, and the results become meaningless. In such cases one of the possible remedies is to shift the base line for s_1 or s_2 to avoid going through zero; another is, if possible, to rewrite the basic equation in such a manner that no division through zero is necessary.

Shift May Affect Accuracy

Unfortunately, the shift of zero point has the disadvantage that the accuracy of the result may be seriously reduced. This becomes evident from analysis of *Fig.* 16 which represents a typical example. In this figure the problem is to get the average ordinate in the interval x_1 of the function $y = f(x)$. This average is defined by

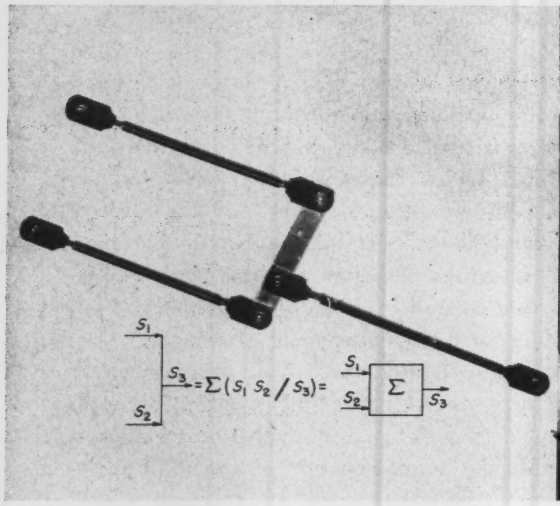
$$y_{ave} = \int_0^{x_1} \frac{f(x)\,dx}{x_1}$$

If x_1 is approaching zero, the problem of dividing zero area through zero becomes formidable.

Shifting the zero x_1, i.e., the origin, to the left by a value x_0 avoids this difficulty but "dilutes" the average by the arbitrary addition with the result that

$$y_{ave} = \frac{y_1x_0 + \int^{x} f(x)\,dx}{x_0 + x_1}$$

is not any longer the true y_{ave} needed. This problem



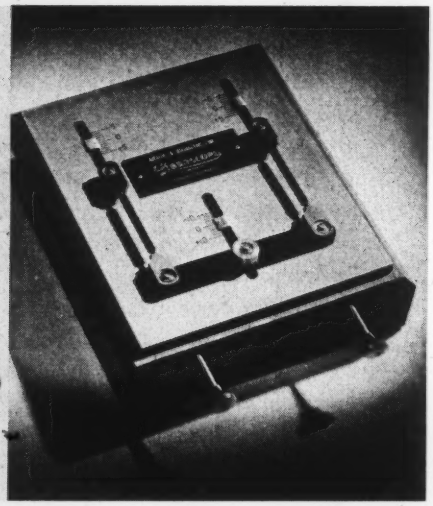


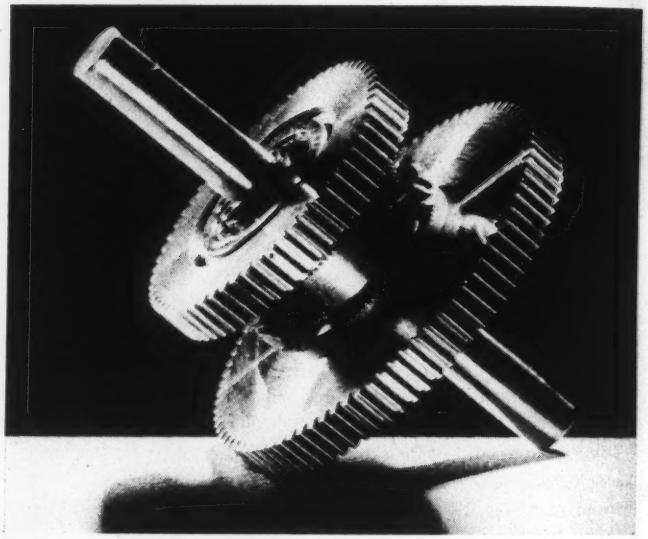
Fig. 8 — Left — Multiple links employed for summing strokes

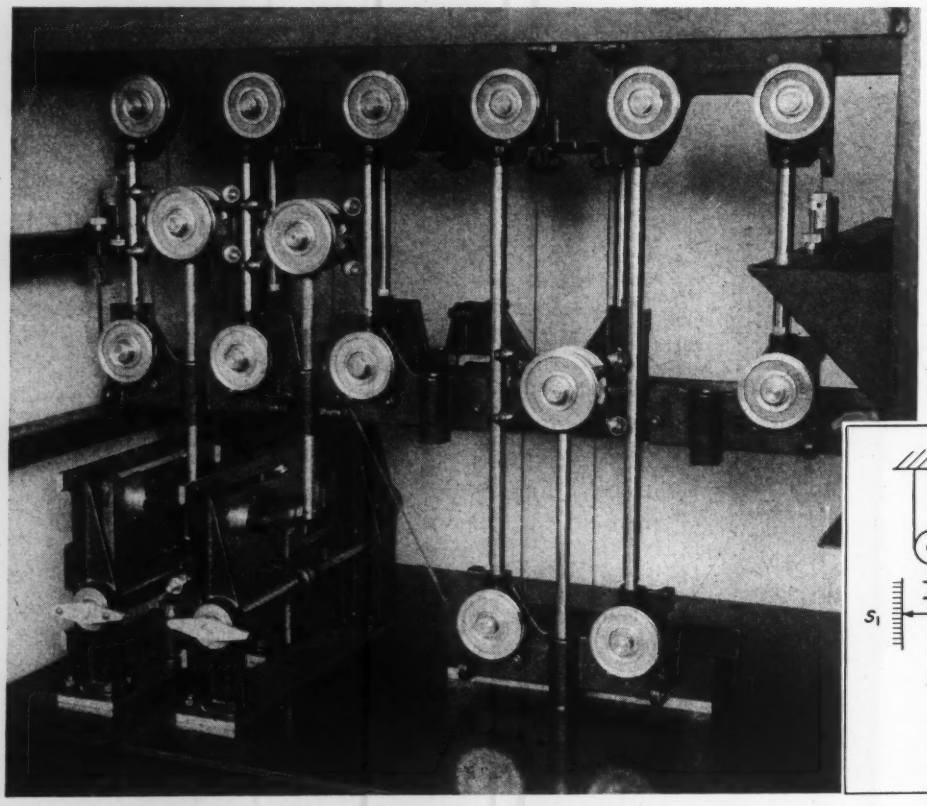
Fig. 9 — Below — Differential gearing for summarization of rotary motion. Design of this unit reduces backlash to a minimum value

is particularly annoying in the design of a computer which continuously calculates statistical data such as standard deviations or the algebraic mean.

NTH POWER OPERATOR: It is possible to get 2nd, 3rd and higher powers of a parameter by using two or more multiplicators in series and repeating the multiplication with the parameter. Use of such a mechanism has already been mentioned in the discussion of a multiplicator for deducting the square of the sum of two variables from the square of the difference. In *Fig.* 17 a mechanical solution is shown schematically.

This variable-speed drive consists of a disk, two spacer balls, and an output cylinder. It is so arranged that the input x not only displaces the spacer which represents the usual adjustment of a variable-





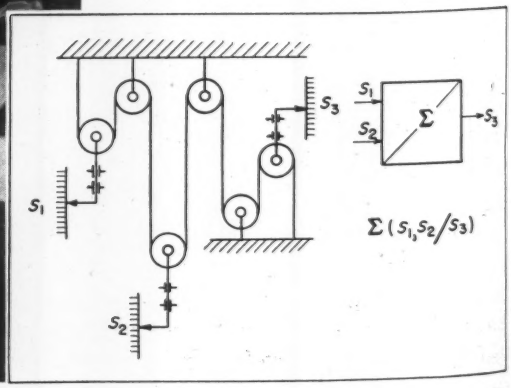


Fig. 10—Left—Cable and pulley system for summarizing strokes. Schematic and block diagram for this system are shown below

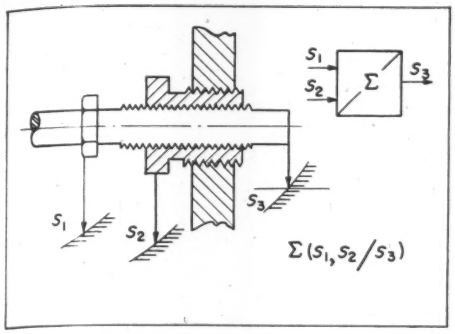
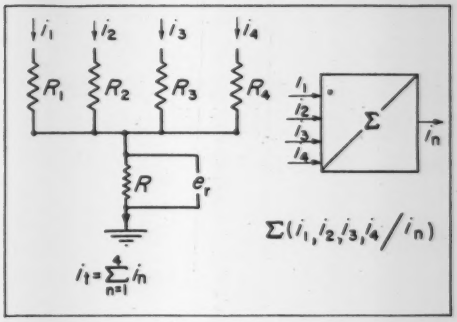
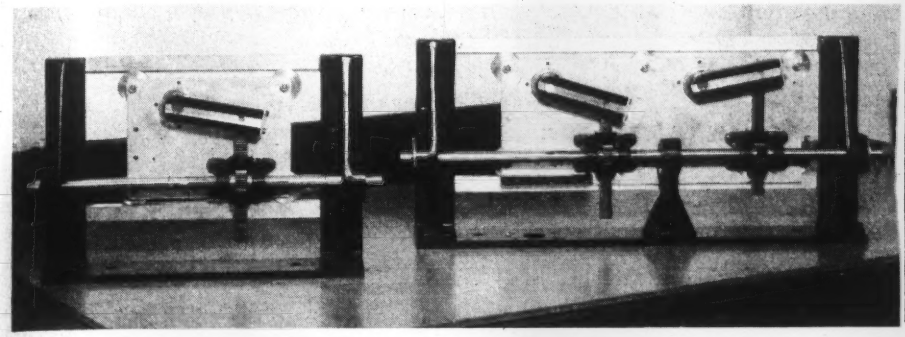


Fig. 11 — Left — Differential screw for summing two rotary motions as inputs

Fig. 12—Right—Circuit representations for summing electric currents





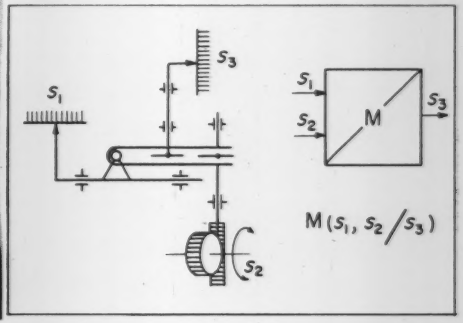


Fig. 13—Mechanical multiplier and its corresponding diagrammatic sketch and symbols

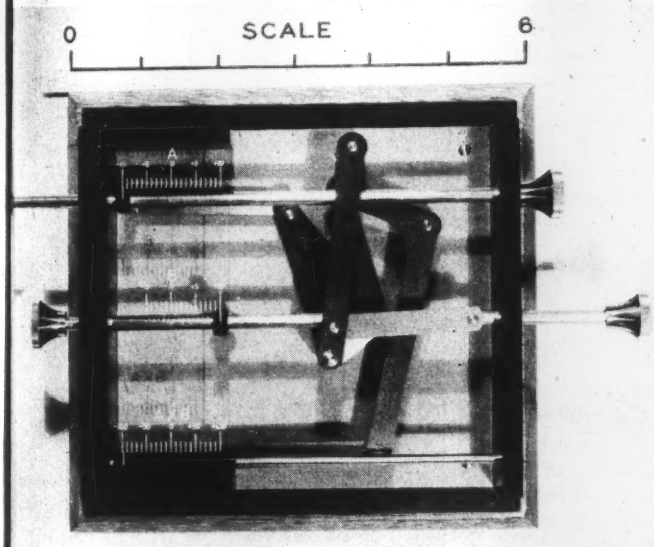
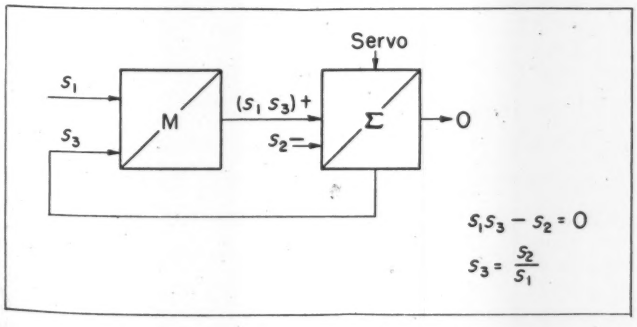


Fig. 14—Linkage arrangement for obtaining the product of two quantities

Fig. 15—Below—Servo circuit for performing division operations, employing a multiplicator and summarizer



speed drive, but also feeds the same variable into the disk drive. With x representing the number of rotations of the disk and also the speed-adjustment factor introduced by the displacement of the spacer, the output becomes x^2.

May Simplify Mechanism

In actual design the variable-speed drive is of a design which avoids any possible slippage by using a cone drive with a positive transmission ratio which changes in direct proportion to the input x. By using forces instead of displacements as the parameter it is sometimes possible to simplify the mechanism. In *Fig.* 18, for instance, the desired output pressure times area or force is to be the 2nd power of the input which happens to be the rate of rotation of a shaft. A centrifugal governor attached to the shaft gives the desired output because centrifugal force of a rotating mass changes with the second power of the speed of rotation. The translator which is added in series to translate this force into pressure is secondary and not essential for the purpose of this discussion.

If electrical parameters are available for the input, such as currents, the attraction of two current coils which produce a force F becomes

$$F = ci_1i_2 \text{ or } F = ci^2$$

This relationship can be and has been utilized to get second powers of currents.

Likewise, in fluid-flow measurement problems, the differential pressure obtained across a restriction varies with the square of flow rate W. This relationship is frequently employed, to obtain second power functions of the parameter W into which other para-

meters can be translated as desired.

In *Fig.* 19, the basic principle in *Fig.* 17 is applied to a series arrangement of two multiplicators translated into an electric circuit. The first potentiometer multiplies the voltage with a factor x while the second multiplicator potentiometer multiplies the result again with the same factor. Both potentiometers are ganged, i.e., their shafts are mechanically connected.

Other frequently used methods are translation of the variable into its logarithm, multiplying this logarithm with the factor representing the power and then retranslation of the output into the antilogarithm. For these two steps of translation either cams or, with electrical circuits, specially wound potentiometers are used. In electronic circuits, tubes are employed having characteristics approximating logarithms. One frequently used approximation of logarithms is a hyperbolic function within the limited range of 2:05 to 1:05.

DIFFERENTIATION OR RATE DEVICES: There is general need for reliable and simple rate devices covering wide ranges of rates or time scales. Theoretically, the best approach is that offered by the rate gyro which produces a precessing moment or force directly proportional to the rotation rate of the axis of the gyro, *Fig.* 20.

By adding a force-stroke translator, e.g., a spring, the displacement s of a pointer becomes directly proportional to the rate of rotation ds/dt. Other translators for the precession force produce directly proportional currents or pressures.

Another type of rate indicating device is based on the addition of a rate vector which is unknown in magnitude to one which is known but 90 degrees displaced. The resultant vector produces an angle relative to the known vector which is a function of the rate vector to be measured. The design element employed for this device is a roller mounted slightly eccentric to a rotating axis. Like the idle wheel of a single-wheel trailer or the tail wheel of an airplane, its circumference will always adjust itself to the tangent of the path of the vehicle, *Fig.* 21. An experimental rate indicator of this type is shown in *Fig.* 22.

Speed of the cylinder v_2 can be varied to change the proportionality factor, i.e., the sensitivity factor of the relationship

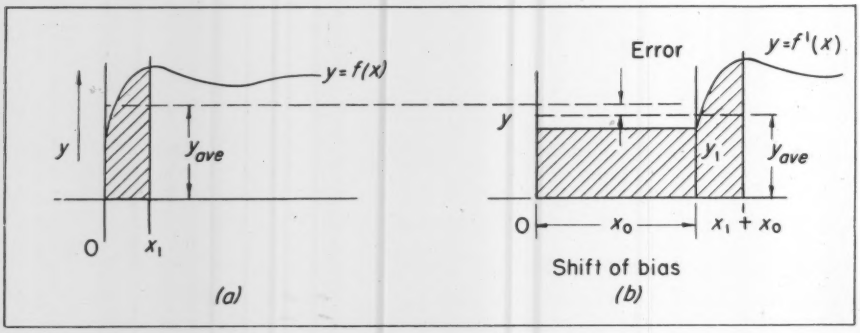
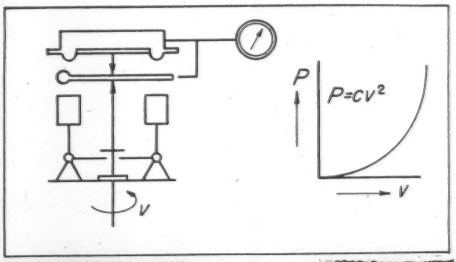


Fig. 16—Above—Graphical representation showing the error introduced by shifting the origin to avoid approaching zero values



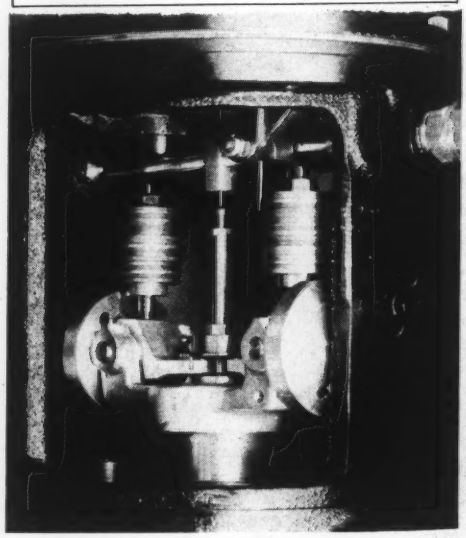


Fig. 18 — Right — Centrifugal force of a rotating mass, being proportional to the square of the speed, is used in this device to obtain the square of the shaft rotation

Fig. 17—Below—Mechanical solution for squaring a quantity, utilizing a variable-speed drive

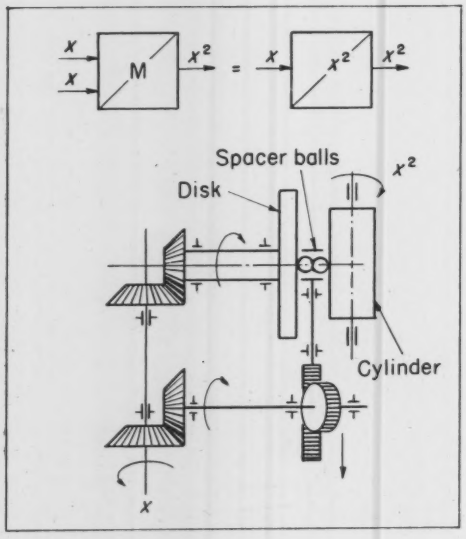
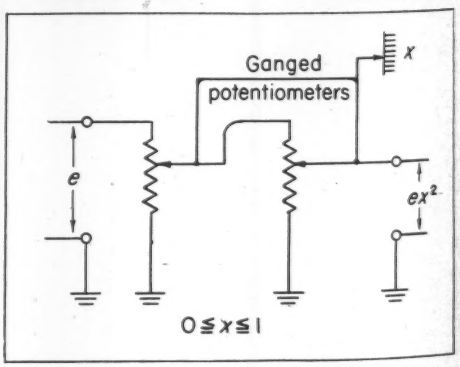


Fig. 19 — Right — Ganged potentiometers multiply voltage to obtain the second power of a quantity



$$\tan \alpha = \frac{v_1}{v_2} = cv_1$$

where the constant c equals $1/v^2$ as derived from the geometry of the vector diagram in *Fig.* 21.

Often a value approaching the derivative is obtained from the difference of an input signal and the output of a delayed follow-up servo system. In simple form, one possible solution uses mechanical components only, *Fig.* 23. The input here is s_1. This input is applied to the summarizer in *Fig.* 23 at point *A*. With *C* stationary, point *B* is thereby displaced and changes the output rate of the variable-speed device.

This moves point *C* at a rate ds_2/dt in a direction to return the point *B* (negative feedback) into its neutral or zero output-speed position. With s_1 continuing to feed at a rate ds_1/dt, point *B* will be displaced by a proportional amount $s_3 = ds_1/dt$. Therefore, s_3 can be used to indicate the input rate ds_1/dt. A translation of the mechanical variable-speed drive into its hydraulic equivalent changes only design details but not the basic approach, *Fig.* 24.

Electrical Circuit Is Equivalent

Going one step further and realizing that the rate signal thus obtained is due to the delay in the feedback or equalizing action of the variable-speed device (or integrating type, as will be shown later) one can draw an equivalent electrical circuit as shown in *Fig.* 25. The condenser will charge at a rate which is proportional to the rate of the applied voltage e_1. Voltage e_3, like s_3 of *Fig.* 24, is an indication of this charging rate.

Another mechanical rate indicator, similar to *Fig.* 22, is based on comparing a vector of known magnitude with one whose amplitude is to be measured, *Fig.* 26. Here the incoming vector (rate of rotation) ds_1/dt becomes the input of a differential gear. A servo loop is added in such a way that ds_3/dt is reduced to zero.

Circuits Are Identical

This requires a displacement s_4 of the variable-speed drive, and this displacement is the value representing the magnitude of the input rate $ds_1/dt = cs_4$. A closer analysis of the circuits in *Figs.* 23 and 26, will show that the two circuits are identical although the philosophy of approach is different in each.

INTEGRATORS: In the preceding paragraphs, variable speed devices have been employed several times as integrators, particularly one type which is known as the "ball and disk" integrator. *Fig.* 27 shows such a unit and how the $\int ydx$ is obtained by rotating the disk an amount dx with a displacement y of the ball. Reproducibility of the integral is as high as 0.01 per cent.

Obviously, any other variable-speed drive will serve the same purpose. If dx/dt is constant, representing time, the problem is simplified to one of introducing y only. Variable-speed electric motors may be used as integrators with the input y being fed into the

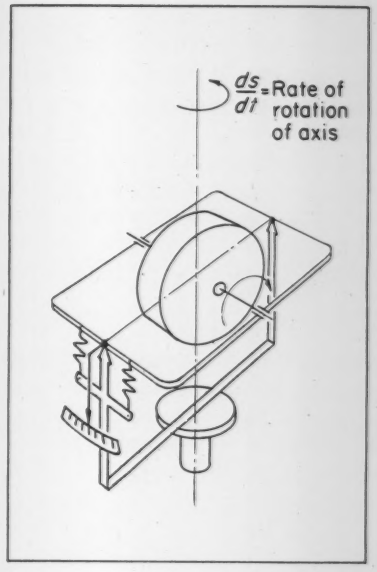


Fig. 20 — Rate gyro has a precessing moment that varies directly as the rotation rate of the gyro axis. Position of the pointer indicates the rate of rotation

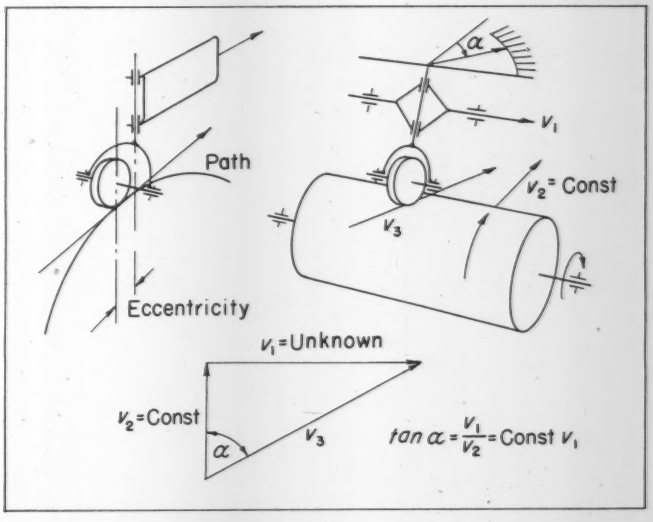
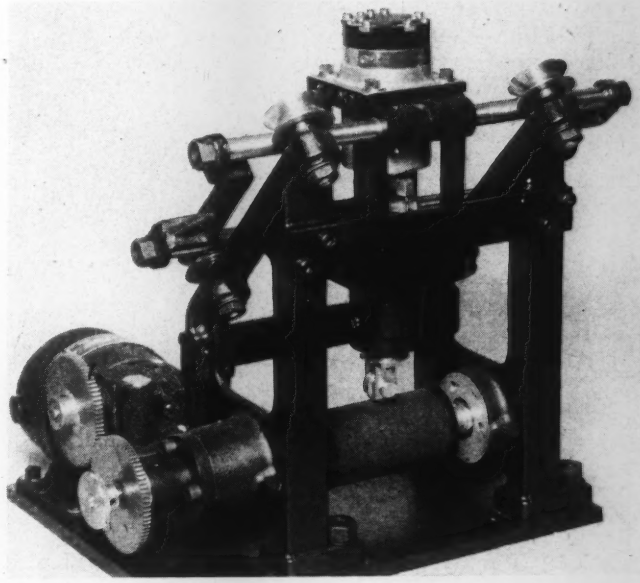


Fig. 21—Rate indicator employing a wheel rolling on a cylinder. Angle of the wheel path is a function of the rate vector to be measured

Fig. 22—Below—Experimental rate indicator employing the principle shown in Fig. 21



mechanism at a constant scanning rate of the function to be integrated. Also, as has been shown, condensers can be used as integrators, assuming leakage across the condensers to be small.

Develops Trigonometric Relationships

FUNCTION GENERATORS: Where the desired output is not proportional to the input, but is instead a function of it, the operator device is known as a function generator. For instance, a sine or cosine function may be required. *Fig.* 28 shows a sine and cosine generator which is based on the fact that a point on the circumference of a circle rolling inside of a second circle of twice its diameter moves on a straight line at a rate which is that of the rotation of the smaller circle times the sine or cosine of its angular displacement.

Cams can also be used to produce these or any other desired relationships between inputs and outputs. There is a whole literature on the subject of cam design[7] and it would go beyond the scope of this study to go into the problem of such design procedure in detail.

One device which avoids difficulties of manufacturing cams employs thin sheet-metal templates. Also, it prevents sticking at points of excessive change of rates of rise and has an additional feature of power amplification. This device is illustrated in *Fig.* 29. It consists of two opposed air nozzles—one supplying and one receiving air—carried by the end of a piston rod of a double-acting hydraulic piston.

This piston is controlled by the constant-pressure regulator shown at the bottom of the unit. As the cam rotates, its circumference moves relative to the receiving nozzle. This varies the pressure in the nozzle and, as a result, the pressure control moves the receiving nozzle in a direction to restore the pressure. Therefore, the two nozzles will always seek the position of coincidence with the rim of the cam. The only contact between the mechanism and the cam is an $\frac{1}{8}$-inch diameter air jet. There being no mechanical contact, no load or wear of the cam results in this design.

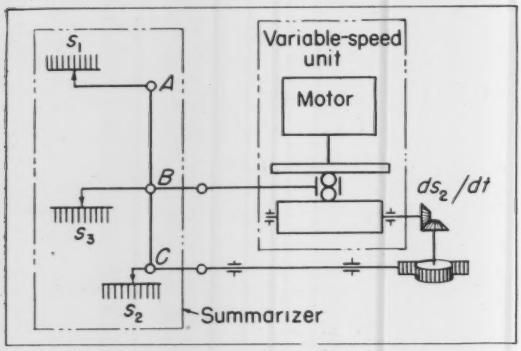


Fig. 23 — Above — Mechanical variable-speed unit employed in a rate indicator

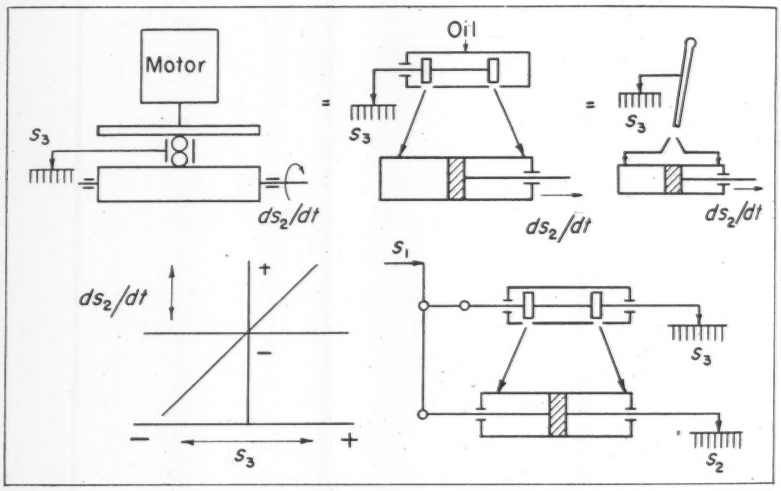


Fig. 24—Above Right—Equivalent hydraulic systems for the mechanical variable-speed unit shown in Fig. 23

Fig. 25—Below—Equivalent electrical circuit for a rate indicator. Measured voltage is an indication of condenser charging rate

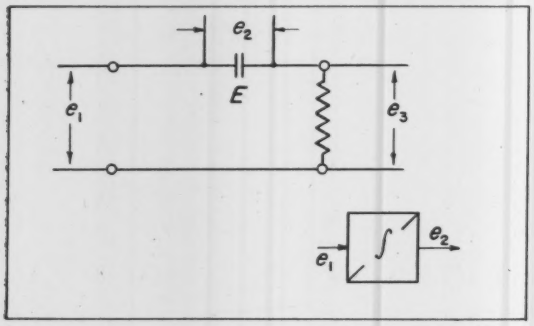
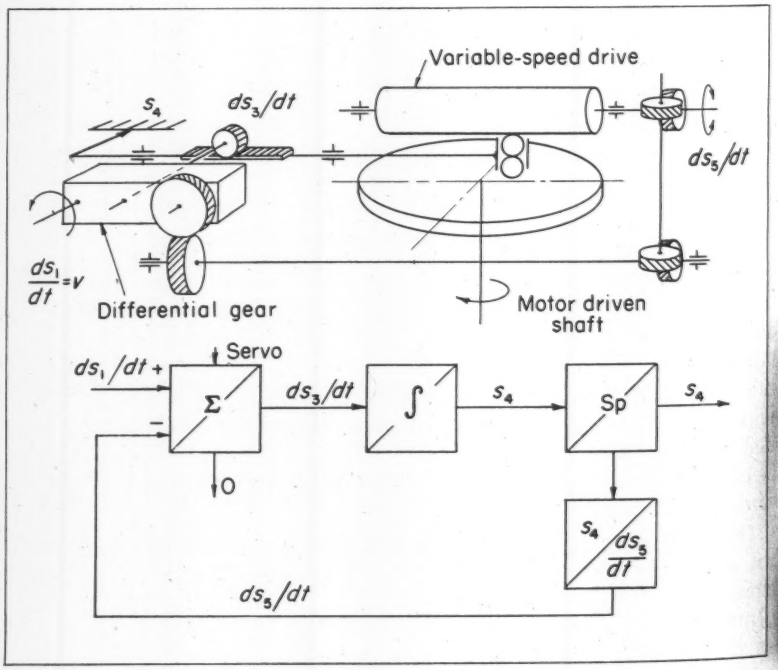


Fig. 26—Right—Mechanical rate indicator, similar to Fig. 22, has a servo loop added



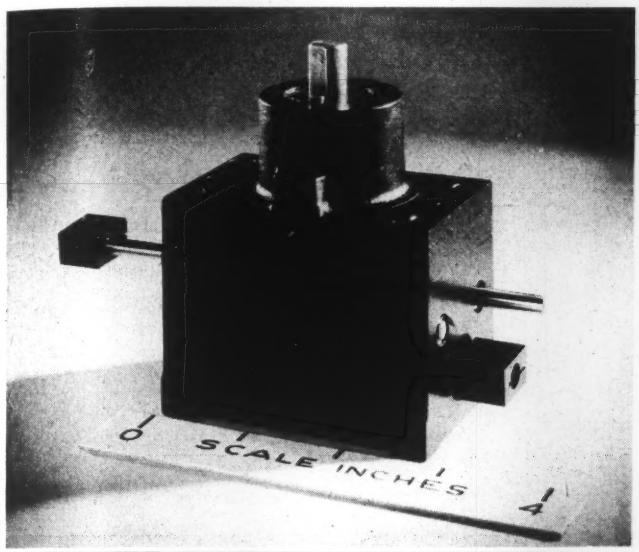
Because it is difficult to produce economically cams of high accuracy for computing mechanisms, another approach has been chosen as illustrated in *Fig.* 30. With this method, it is possible to obtain a great variety of functions as the output of 4-bar linkages of various lengths.

In order to investigate systematically all possible functions, a device shown in *Fig.* 31 was constructed. With this instrument it is possible to match experimentally any desired function with 4-bar linkages and to determine the maximum errors which are introduced by this approximation. The availability of such experimental devices and a general catalog of possible patterns will offer many short cuts to machine and computer designers.

Applications: This analysis has provided a general survey of the concept of operators and translators. By a systematic study of economic considerations and accuracies as well as time constants, availability, and space and service requirements, it is possible to translate designs into equivalent mechanisms with different and more suitable parameters. If, for instance, the basic requirements of a device—computer, regulator, simulator, etc.—calls for many derivatives with low time constants, electrical circuits appear preferable to a pure mechanical solution. They take advantage of simple differentiator and integrator operators.

May Obtain More Suitable Characteristics

In such cases, it may be desirable to translate those parts of the block diagram containing the differentiators into electrical parameters and retranslate the final output of this section back into those parameters which are finally desired as outputs. In a typical application, the method outlined in this study was used to vary a given design by systematically translating it into force, stroke, current, and voltage parameters. The prototype used pressure as the com-



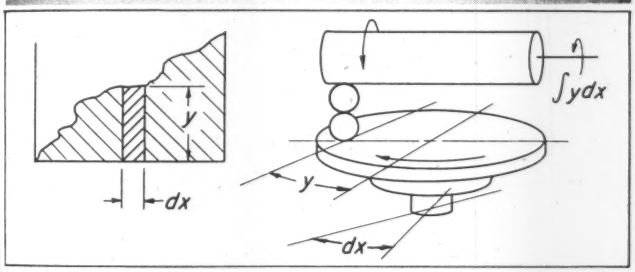


Fig. 27—Above—Variable-speed device using disk, balls and cylinder as illustrated in several previous sketches

Fig. 28—Below—Sine mechanism produces linear motion at a rate proportional to the rotation of the smaller circle and the sine of its angular displacement

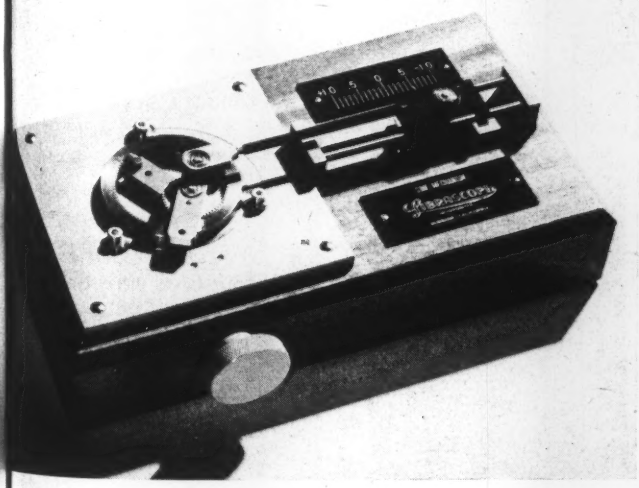
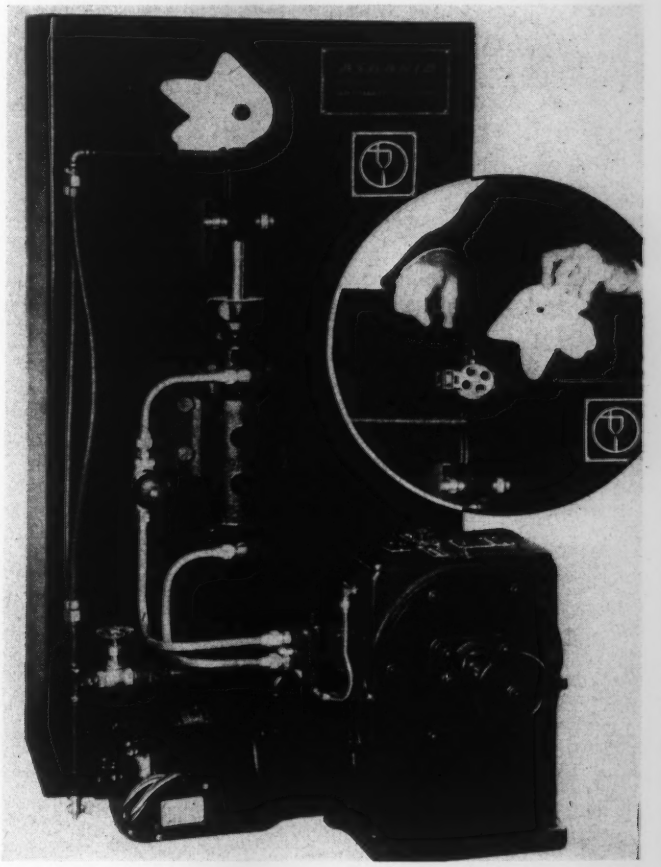


Fig. 29—Tracer mechanism follows the cam path as the cam rotates to maintain pressure between air jet and receiving nozzle at cam periphery



mon denominator. Altogether 35 solutions were found where previously only four were available, including the pressure system. Although many of the 35 were impractical, sufficient number offered satisfactory or better solutions than the original.

Gives Answer to System Behavior

For those interested in the dynamic overall behavior of such a translator chain, the analysis or block diagram gives directly the answer of dynamic overall behavior of the system. By applying the rules of La Place transformation to parallel and in-series arrangements of individual elements whose La Place transform is known, all the possible solutions are obtained. If F_1, F_2, F_3 represent the La Place transforms of individual translators, we obtain by an in-series or chain arrangement an overall transform $F_n = F_1F_2F_3 \ldots$ and in case of a parallel circuit $F_n = F_1 + F_2 + F_3 \ldots$ while a feedback circuit with F_2 in the feedback furnishes $F_n = F_1/(1 + F_1F_2)$.

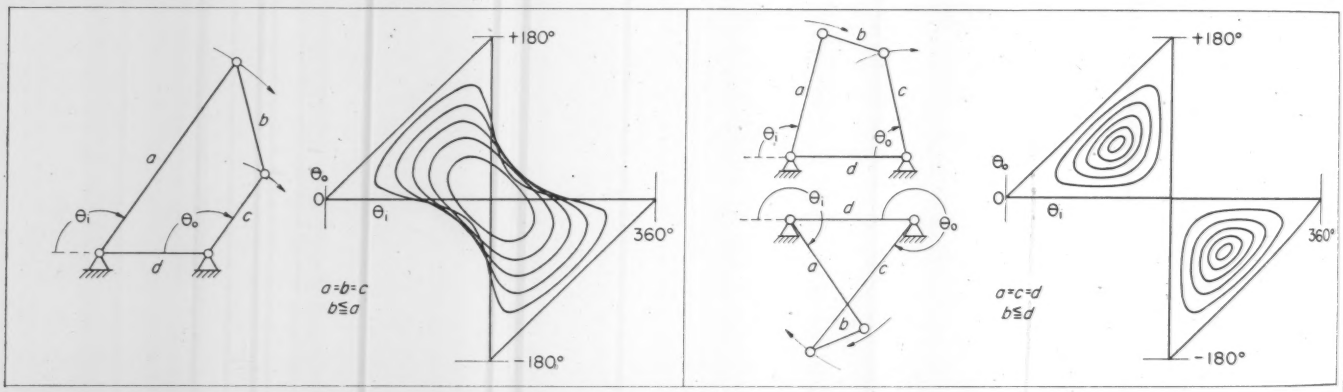
It is hoped that a systematic survey of translators and operators—giving specific data on their accuracy, price, characteristic, size, weight, serviceability, life expectancy, availability and La Place transform—will become available in the future. This appears to be a worthwhile project because it would enable the designer to explore systematically a great variety of possible solutions instead of limiting himself to the few obvious ones which are available or appear to be promising. Last, but not least, it will serve to clear the relentlessly growing wilderness of "new" patent ideas as many of the sparks of genius will show themselves as variations of a theme.

Suggestions of Prof. D. P. Campbell, Mr. Guido Wuensch, Mr. Paul Glass and Dr. M. E. Droz are gratefully acknowledged. The following photographs were furnished by:

Askania Regulator Co. ..... *Figs.* 10, 13, 18, 22, 29
General Precision Laboratory Inc. ..... *Figs.* 30, 31,
Librascope Inc. ..... *Figs.* 8, 12, 14, 27, 28

REFERENCES

1. "A New Approach to Design," MACHINE DESIGN, June, 1947
2. H. Ziebolz—"Designing Hydraulic Servos," MACHINE DESIGN, July, 1947
3. H. Ziebolz—"Designing Pneumatic and Electric Servos," MACHINE DESIGN, Sept., 1947
4. F. W. Cunningham—"Employing Computer Components in Machine Control," MACHINE DESIGN, May, 1950
5. H. Ziebolz—"Ratio and Multiple-Fuel Controls in the Steel Industry," *Transactions ASME*, Nov., 1944
6. H. Ziebolz—*Relay Devices and Their Application to the Solution of Mathematical Equations*, Askania Regulator Co., 1940
7. Macon Fry—"Designing Computing Mechanisms," MACHINE DESIGN, Aug. 1945 to Feb. 1946
8. Gordon S. Brown and Donald P. Campbell—*Principles of Servomechanisms*, John Wiley & Sons, Inc., 1949
9. H. Ziebolz—*Analysis and Design of Translator Chains*, Askania Regulator Co., Sept. 25, 1946



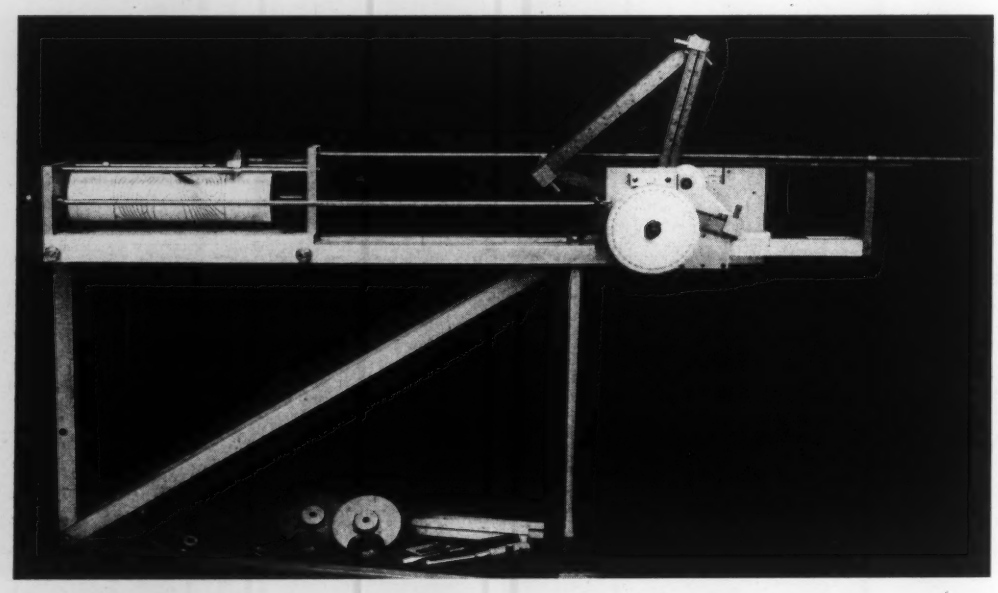


Fig. 30—Above—Typical paths traced by four-bar linkages for rotating connecting-rod and rocker type linkages

Fig. 31—Left—Device employing four-bar linkages will match any motion and determine maximum errors

HEAT TREATMENTS

. . . Their Selection and Specification in Design

By Norman N. Brown
Resident Manager
Cincinnati Branch
Wheelock, Lovejoy & Co. Inc.
Cambridge, Mass.

Part 3—Combination Hardness and Toughness

THIS series of three articles has been written primarily to aid the designer and engineer in selecting and specifying heat treatments that will result in the attainment of the desired physical properties in various machine parts. Part 1 covered a brief resume of types of steels and discussed treatments suitable for developing physical properties associated with toughness. Part 2 of the series discussed those associated with hardness and this final part will deal with heat treatments pertinent to the heat treating category of combination hardness and toughness.

Because combination hardness and toughness represents a compromise between hardness and toughness in most cases, there are almost endless variations in the specifications possible and only the most common and general situations which cover the majority of parts falling in this classification can be treated.

Normalizing: Generally this treatment is used in the interests of toughness and hardness in the processing of very large bars which do not respond well to the usual quench and draw methods described under Normalizing in the Toughness category, Part 1. It is, as mentioned before, always desirable to normalize forgings prior to subsequent treatments.

CASE HARDENING: Low-carbon alloy steels are generally used on jobs which require a very hard wear surface and some degree of toughness. It has been customary to state, in such instances, that the use of alloy steel results in a hard case backed by a tough core to resist shock loads. However, some questions have been raised that cast some doubt as to this statement, on the theory that any impact strong enough to tax the physical properties of the core would have cracked or shattered the case long before reaching the core.

If this new line of thinking holds true, it would seem as if the physical properties of the core have other functions. One of these is that the core must be hard enough to back up the case and thus resist crushing of the case by heavy pressure. The car-

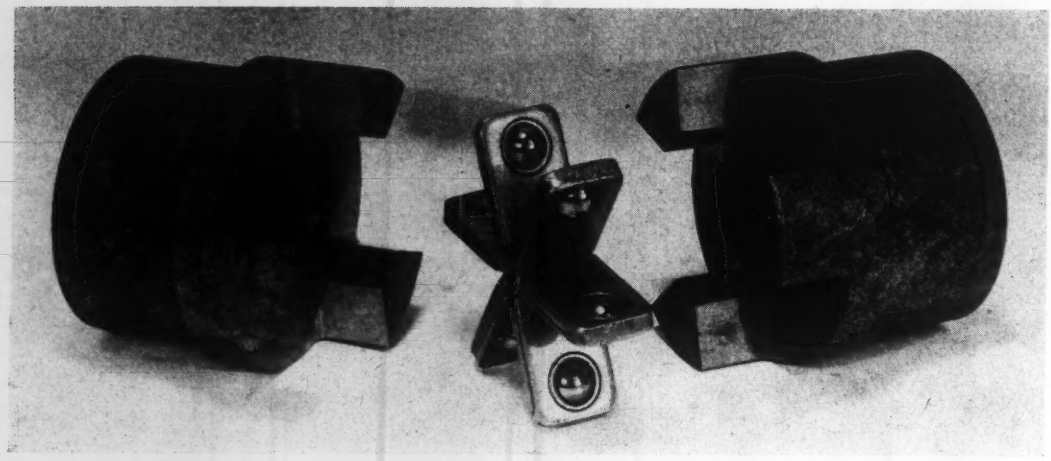


Fig. 10—Left — Flexible shaft coupling of ball-bearing design made from a carburized low-carbon alloy steel

burized AISI A-4620 type pinion gears shown in *Fig.* 6 illustrate this point. Another use for a tough core is on parts which are selective case hardened where those portions not hardened must have strength.

Straightening after case hardening is another instance which requires good core properties especially on parts of slender design such as shafts, slides, etc., that are likely to distort considerably during treatment. The importance of this factor was brought out clearly in the case of some long tool bodies. Originally a steel of AISI C-1117 type was used; the parts were finish machined, pack carburized and hardened to produce a case about 0.065-inch deep, given a short, low draw of 250 F for fifteen minutes to relieve strains, straightened, and ground. In service the bodies were satisfactory, but the difficulty was that too many pieces cracked in the straightening operation before they could be put into service. Investigation revealed that although the case had enough strength to resist the straightening stresses, the core did not in those parts that broke. AISI A-4615 was then used, being given the same heat treatment. The better response of A-4615 to the treatment resulted in a substantial reduction in the number of cracked parts.

As under the Hardness category, it is difficult to state in so many words how thick a case should be, as service conditions vary widely. Usually the case thickness should not be more than one-sixth of the section thickness if toughness is to be maintained. The flexible ball-bearing coupling in *Fig.* 10 is an interesting part fitting into this discussion. It was machined from a low-carbon alloy steel, carburized and hardened to develop a case 0.060 to 0.070-inch deep with a hardness of 62 to 65 Rockwell C.

Hardening of Thin Sections

Parts, such as spray nozzles of various kinds, with thin cross sections require extreme care to prevent case hardening all the way through. Such sections become too brittle for practical use. Liquid salt baths, which in general permit close control of case thickness—more so than pack or gas carburizing—can be used to good advantage on these jobs. There are many good salts on the market that can be considered including DuPont, A. F. Holden, E. F. Houghton (Perliton), and Chapmanizing salts. Developments in salt-bath treatments in recent years have made possible cases approaching the depth and toughness of those produced by pack or gas methods. In general, however, a case developed by salt bath is thinner and more brittle.

One of the advantages of case hardening is that it increases fatigue resistance. Fatigue failures are tensile failures and the case hardening introduces surface compressive stresses which counteract applied tensile stresses. For this reason, as well as to obtain better wearing qualities, some crankshafts, such as that in *Fig.* 11 which was made from a special 4616 steel, camshafts and other similar parts are often carburized.

Standardize Specifications

The specifying of case-hardening treatments can be set up in a manner similar to that suggested under the Hardness category, keeping in mind possible distortion as well as the service conditions to which the case itself will be subject, which may or may not rule out a brittle case.

There are occasions when a part requires the core characteristics of a heat-treated medium-carbon alloy steel and, at the same time, must be very hard to resist sliding wear and to a small extent pressure as contrasted to a case that has to be heavy and resist shock applications. In such instances—medium-duty gears of certain types, toggle pins, etc.—a medium-carbon alloy steel (0.30 to 0.40 per cent and sometimes up to 0.50 per cent carbon) is used with a cyanided case. Usually the depth of the case is quite thin being 0.005 to 0.015-inch deep, but sometimes it is possible to obtain a depth of 0.035-inch. Parts, however, must be so designed that little distortion occurs in treatment because of the thin case which will not permit much grinding. Selective case hardening as on bearing surfaces may be employed also.

The chart in *Fig.* 12 shows in a general way the relationship of case thickness to overall service conditions on parts requiring a tough core and a hard, wear-resistant surface.

Nitriding (particularly selective): This treatment is good if an exceptionally hard surface combined

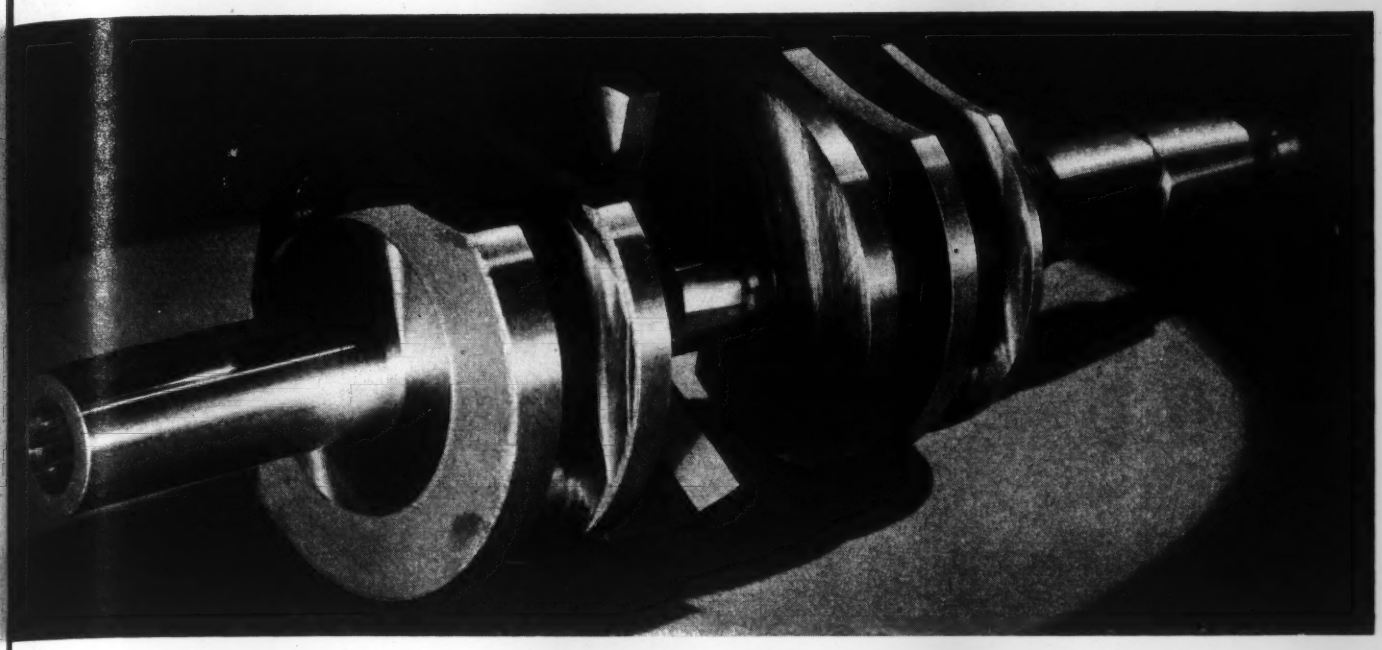


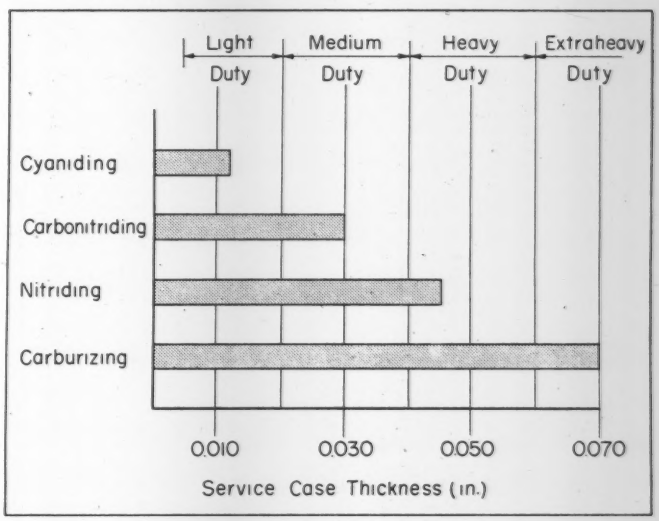
Fig. 11—Above—Engine crankshaft made from a special AISI 4615 type steel case hardened by carburizing

with tough body qualities is required. As was brought out before, special nitriding steels marketed under the name Nitralloy are most commonly used, but many medium-carbon alloys can also be effectively nitrided. Use of the latter grades results in a somewhat tougher case not quite as hard as that produced with Nitralloy. Since the average nitrided case is brittle and thin its use should be restricted to parts where that condition will not be a disadvantage.

When a part is to be nitrided, the surface should be clean and free of any decarburization. The steps in processing prior to nitriding follow the general pattern of those discussed under the Toughness category. If much machine work is to be done on preheat-treated material, it is usually stress relieved just prior to finish machining. This eliminates machining strains that might cause distortion in the subsequent nitriding operation. Because no quenching is involved in nitriding, distortion is usually negligible, except in the instance just mentioned where unrelieved machining strains cause difficulty. Nitriding is usually carried on between 900 and 1200 F so in the heat treatment of the steel before nitriding the drawing temperature will of necessity have to be about 1200 F or higher. Occasionally this point is overlooked by the designer and hardness or physical properties requiring a lower draw are specified which, of course, would be changed in the final higher heat of nitriding. Gears, pump shafts, liners, crankshafts, and rolls are among parts that are nitrided.

SURFACE HARDENING: The mechanics, precautions and other information concerning flame and induction hardening described in the Hardness category apply under these circumstances. When toughness is to be considered, the physical properties of the part will determine what steel and treatment to use prior to surface hardening and the procedures and suggestions under the Toughness category can be followed. In the interests of toughness, usually one of the steels in Groups III and IV, *Fig.* 1, (C-1045, A-4640, A-4142, etc.) heat treated to the proper physical properties is used.

Fig. 12—Below—Chart showing relationship of case thickness to overall service conditions of hard-tough parts. Amount of distortion anticipated and amount of grinding must be added to obtain total depth of case needed. Gas carburizing will actually permit case thicknesses of 0.300 to 0.400-inch if desired. Medium-carbon alloys are generally cyanided and do not exceed 0.012-inch case. Low-carbon alloy steels are suitable for the full range



Steels with 0.40 to 0.45 per cent carbon content have been the ones most commonly used for flame and induction hardening but improvements in technique, equipment and quenching solutions have made it possible to use steels with up to 0.50 per cent carbon without taking particular precautions during treatment. An example of this is the use of a special 0.50 per cent carbon high manganese-chromium-molybdenum alloy steel for heavy duty gears, pinions, etc. In addition to being an exceptionally good ma-

chining steel it has deeper hardening qualities (due in part to the 0.50 per cent carbon) than the 0.40 per cent carbon grades. This is an advantage on deep-cut parts machined from preheat treated stock in which the physical properties of the deep-cut sections have to be close to those of the shallow-cut sections.

Response of this steel to flame hardening is shown in *Fig.* 13. The material (4⅛-inch round) was machined to the irregular shape shown and then cut in half making two pieces 2½ inches long. The darkened surfaces were flame hardened and quenched, etched on the surface and midsection to show the heat-affected zones. A hardness survey on the hardened faces show the affected zones with Rockwell C hardnesses as given in *Fig.* 13.

Low Distortion Hardening

Normally, the distortion on flame or induction hardened pieces is very slight, but there is apt to be considerable distortion if only one surface of comparatively long parts, such as slides, is hardened. In such cases distortion can be minimized by also surface hardening the other side. The moral here is that parts should be surface hardened as symetrically as possible. If a part is very fussy and has close tolerances, a steel with air hardening properties (as far as flame or induction hardening is concerned), *Fig.* 13, can be used advantageously. Distortion, if any, would be less than if an oil or aqueous quenching solution were used as a quench. Crankshafts, gears, pinions, rolls, spindles, and worms are among parts that can be surface hardened. *Fig.* 14 shows a miscellaneous group of parts that have been induction hardened.

THROUGH-HARDENING: The possibilities for the use of this treatment, which, as mentioned before, basically involves heating, quenching and drawing, are wide and varied. For this reason and also for its comparative simplicity it is one of the most popular and extensively used methods of obtaining hardness and toughness. It is probably safe to say that most of the parts thus treated are not as ideally hard or tough as would be desired, but hard and tough enough for practical and economic processing and service.

Medium-carbon alloy steels in Groups IV and V, *Fig.* 1 (A-4140, A-4340, etc.) are used at hardnesses from about 32 to 50 Rockwell C for the majority of jobs in this category. From 50 to over 60 Rockwell C, special tough oil and water-hardening higher carbon steels are used. These are grades such as AISI A-9262 and others usually marketed under tradenames by reputable steel companies. Basic facts to keep in mind are that as the hardness increases the tensile and yield strength increases which is beneficial to some parts subject to straight pulling stresses and very little bending or other "side" forces. As hardness increases, the elongation, reduction of area, and impact strength decreases, which is detrimental to most parts such as shafts, gears, pinions, studs, clutch dogs, etc., in this Hardness-Toughness category.

Before going over the various possible heat treating specifications a short review of the factors involved in determining whether to use a medium-alloy in Group IV, *Fig.* 1, or a rich alloy in Group V might be worthwhile.

Medium Alloys (AISI A-3140, 4140, etc.): Steels in this group are best adapted and most widely used for heavy-duty shafts, gears, axles and studs which must withstand heavy loads, wear, shock, bending, and the like. Generally speaking, these steels are used on parts at hardnesses under 50 Rockwell C.

Response to Heat Treatments

Rich Alloys (AISI A-4340, 2345, etc.): Response to heat treatment by oil quenching, especially in massive sections, and splendid resistance to shock in the heat-treated condition characterize the steels in this group. These steels are used for much the same parts as those in the medium-alloy group, but where greatest possible strength is required. In the lower hardness ranges (under 321 Brinell) in smaller sections (under 3½-inch) there is no marked difference in physicals between this and the medium-alloy group. In the higher hardness ranges and larger sections when heat treated this group shows up to best advantage. (Cost is also greater than for medium-carbon alloys.)

As brought out in discussing through-hardening in

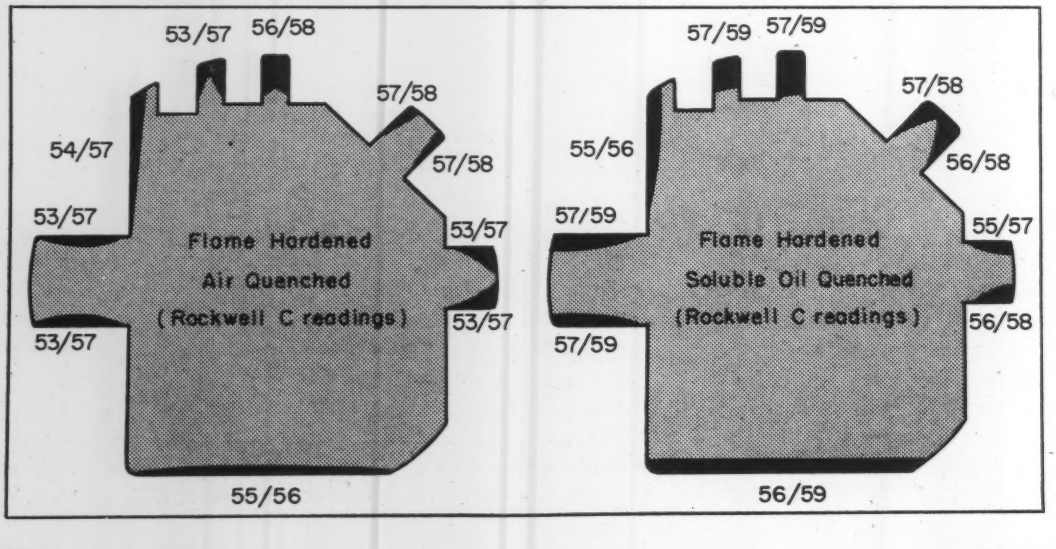


Fig. 13—Hardness readings on various projection designs showing response of a special 0.050-carbon high-manganese - chromium-molybdenum alloy, flame hardened, using air and soluble oil quench

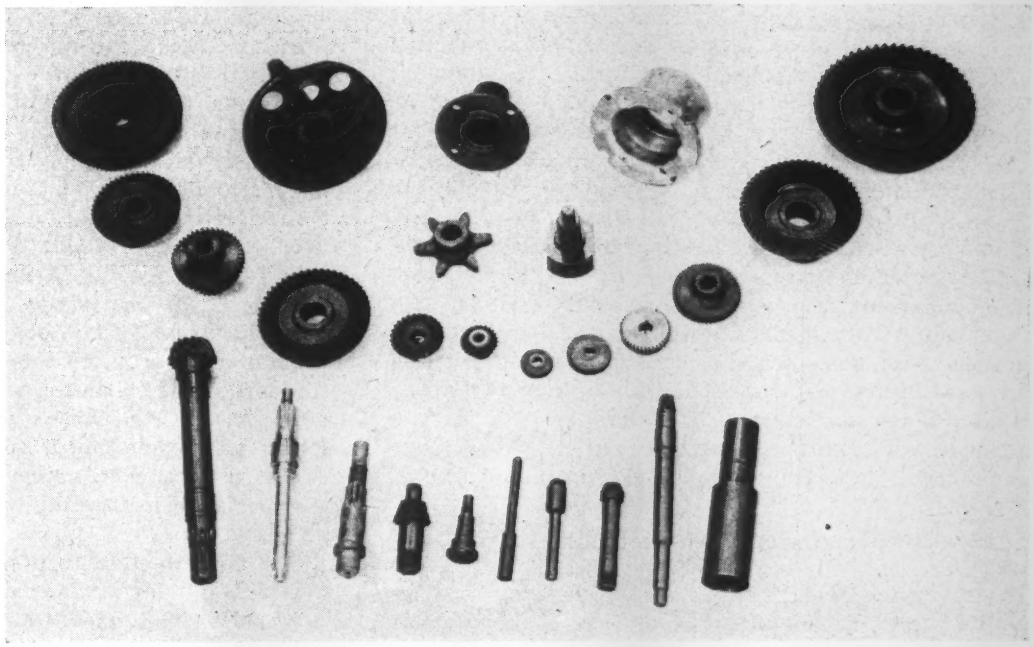


Fig. 14—Right — Group of miscellaneous gears, shafts and pinions hardened by the induction method

Photo, courtesy General Electric

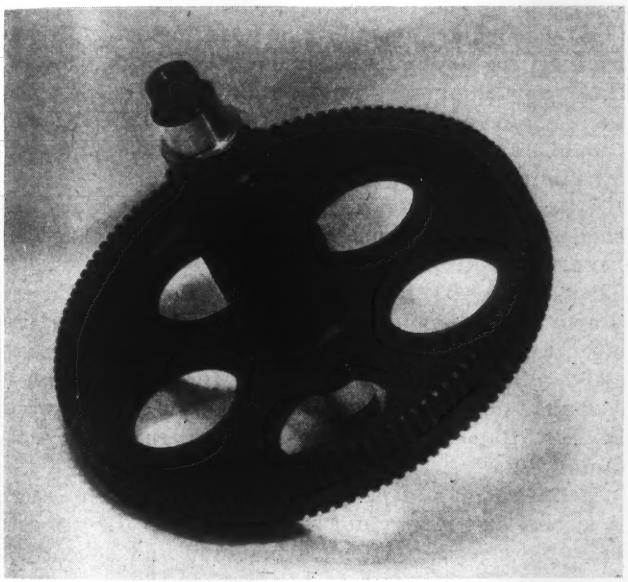


Fig. 15—Gear machined from a medium-carbon alloy steel forging and heat treated to 48 to 50 Rockwell C

the Toughness category, the medium-carbon steels vary in machinability in the heat-treated condition. Hardness of 32 or 33 Rockwell C is about the limit at which most of the standard grades are being rough machined economically at the present time although some of them, at some sacrifice in cost, can be machined at hardnesses up to about 36 Rockwell C. There are some tradename steels on the market with similar physical properties that machine considerably better than the standard grades in the 32 to 38 Rockwell C hardness range. Plant facilities, price, processability, and other factors are accorded varying degrees of importance in different companies, resulting in different heat-treating procedures to achieve the same end result. The most practical approach, therefore, will be to suggest heat-treating specifications which can be used effectively, keeping in mind the pertinent factors concerning types of steels and machinability. These specifications are:

Parts machined from preheat-treated steel (32 to 38 *Rockwell C*)
- Comparatively symmetrical or chunky design
  - Heat treat
  - Machine
- Compartively long or intricate design
  - Heat treat
  - Stress relieve (to relieve straightening strains)
  - Machine

Parts heat treated after machining (32 to 50 *Rockwell C*)
- Comparatively symmetrical or chunky design
  - Anneal
  - Machine
  - Heat treat
  - Grind

  or
  - Anneal
  - Rough machine
  - Heat treat
  - Finish machine
  - Grind
- Parts of comparatively long or intricate design
  - Anneal
  - Rough machine
  - Heat treat
  - Finish machine
  - Grind

  or
  - Anneal
  - Rough and finish machine
  - Stress relieve
  - Heat treat
  - Grind

  or
  - Anneal
  - Rough and finish machine
  - Martemper (fully effective in sections up to about 3 inches)
  - Grind (can stress relieve before Martempering if desired)

The gear in *Fig.* 15 was made from a medium-car-

bon alloy-steel forging. After normalizing and annealing, the steel was rough and finish machined, heat treated (oil quenched and drawn) to 48 to 50 Rockwell C, and used as shown without grinding or cleaning.

Many parts such as clutch units, liners, bushings, rolls, cams, and locating pins requiring hardnesses from 50 to over 60 Rockwell C are made from the high-carbon (0.60 to 1.10 per cent carbon) oil and water-hardening steels because deeper high hardness and strength is wanted for wear or other reasons than can be obtained with the use of lower carbon grades. Also, some of the tougher oil-hardening steels are used in lieu of carburized steels to take advantage of the lower distortion in treating as well as the adequate strength and wearing qualities. Chuck jaws and clutch dogs are examples of such applications.

Tempering Requirements

Attention should be given to the drawing or tempering time if toughness is of special importance when a high-carbon steel is used. An hour to an hour and a half per inch of cross section is the usual length of time necessary at drawing heat to obtain proper hardness. If that drawing time is extended to two or three hours per inch the toughness will be substantially increased with little change in hardness. The designer should definitely specify the longer draw if he thinks it necessary because, unless he does, the heat treater will usually only draw the normal length of time.

Shallow-hardening water-quenching steels are used on jobs requiring a very hard (62 to 68 Rockwell C) case from ⅛-inch to ⅜-inch deep backed by a hard, touch core. The jeweler's lathe spindle assembly in *Fig.* 16 was made from such a steel. The parts were machined from annealed bar stock, heat treated to about 64 Rockell C and ground.

The heat treating specification for these high carbon steels is generally set up as follows:

Anneal (bar stock is usually furnished in the annealed condition)
Rough and finish machine
Stress relieve
Heat treat
Grind

If conditions are favorable, parts made from the high-carbon oil-quenching steels can be Martempered, Austempered or Isothermally treated as described under Through-Hardening in the toughness category.

In concluding the discussion of combination hardness and toughness, the following example clearly illustrates the number of factors that have to be taken into consideration in selecting a steel and treatment and why specifications should be as flexible as possible, or at least thoroughly investigated before setting them down on paper. The part in question was a gage, about 6 inches long, threaded for about 2½ inches and ⅞-inch hexagon for the balance of the length. For gaging purposes, the hexagon portion had to be over 60 Rockwell C hardness.

First made from cold-drawn C-1020 hexagon stock, the piece was carburized and hardened all over to 63 Rockwell C. Because of service stresses the threads chipped on some gages and others broke across the threaded section. Furthermore, considerable distortion occurred in treating which necessitated excessive grinding.

The first thought to improve the part was to use a low-carbon alloy and case harden the hexagon section only. This idea was discarded when hexagon, low-carbon alloy steel was unavailable. Next, a medium-carbon alloy which could be obtained in hexagon sizes was considered with the thought in mind of flame hardening, cyaniding or nitriding after preheat-treating for toughness. This was discarded because flame hardening would not develop a sufficiently hard surface, cyaniding would not produce a case deep enough, and nitriding was too expensive and time-consuming a treatment.

Finally made from a tough 0.75 per cent carbon oil-hardening steel, round bar stock was used and the hexagon section machined. The gage section was hardened to 62 Rockwell C and the threaded end drawn back to about 45 Rockwell C. The oil-hardening steel was selected instead of a low-carbon alloy, which could also have been machined from round stock in a similar manner, because distortion in treating would be less. Reports indicate the gages are giving satisfactory service.

Ramifications of heat treating processes and specifications are many and varied. Those discussed in these articles are the most common and cover most general situations. It is hoped that presentation in this manner will provide the design-engineer with a clearer insight into this complicated subject which will help eliminate improper heat treating which can lessen and even nullify the effectiveness of expensive and otherwise carefully designed machine parts.

Fig. 16—Jeweler's lathe components made from a shallow-hardening type special 0.95-carbon water-hardening steel

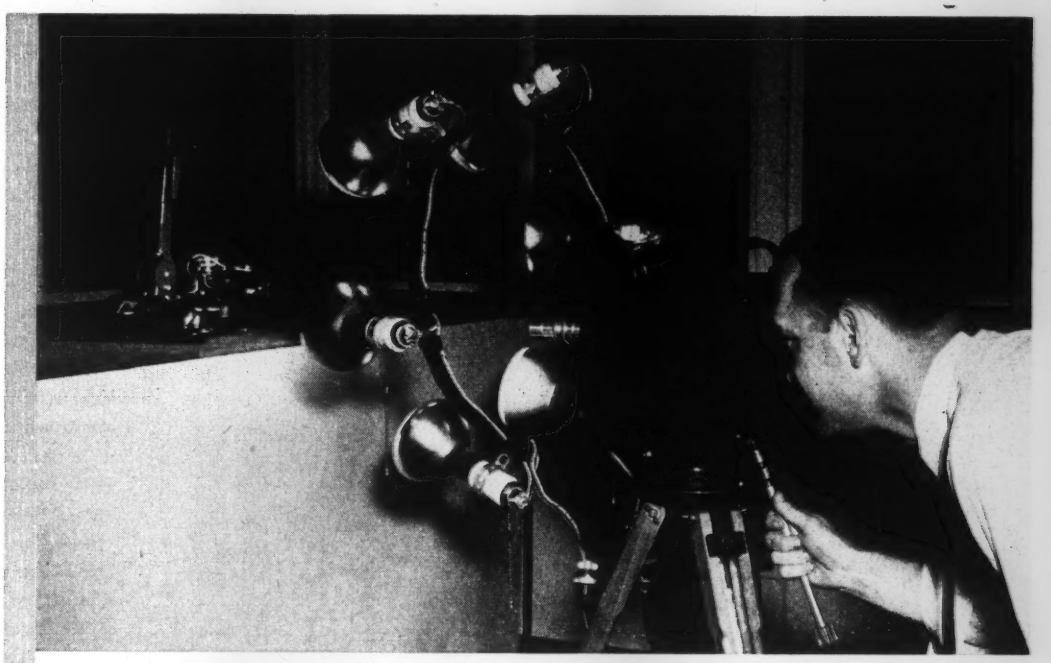


Fig. 1—Setup for a high-speed motion picture study of a vacuum cleaner

High-Speed Motion Pictures

. . . detect defects in design

By
L. G. Waller
Research Engineering
Eureka Williams Corp.
Bloomington, Ill.

ALTHOUGH high-speed motion pictures are generally regarded as an aid to proportioning of machine parts they also can serve as a guide to the selection of materials. For example, if excessive wear is suspected, theoretical calculations frequently cannot offer a concrete answer as to whether the wear results from wrong proportions or from a failure of materials to perform as predicted.

In solving such problems, motion pictures of 1000 frames or more per second help the designer to observe what actually occurs during operations and to assign the fault where it belongs. These motion pictures, projected at the standard silent speed of 16 frames per second, effectively "magnify" time by factors of from 65 to 200. In other words, a cycle actually taking place in 1/100-second may appear on the screen for as long as two seconds.

To show the effectiveness of motion pictures in design analysis, this article outlines two actual cases in the experience of the Eureka Williams Corp., manufacturer of vacuum cleaners and oil-fired heaters.

VACUUM CLEANER BELT: In attempting to increase the life of the drive belts used in its upright cleaner models, Eureka was confronted with the question of whether the belt at normal speeds had sufficient clearance to vibrate without rubbing the base or the top of the cleaner casting. Since the brush roll driven by the belt rotates at 3500 rpm, suspected abrading action could not be observed with the unaided eye.

To permit photographing the belt at a speed of 3000 frames per second, a part of the casting was cut away. A Kodak high-speed camera surrounded by six photo spot lights was used to take the motion pictures of the belt's travel between the drive shaft and the brush roll, *Fig.* 1. Separate exposures were made of a belt when new and after equivalents of three, six and nine month's wear.

As evidenced in *Fig.* 2 (consecutive frames enlarged from the film) vibration was not excessive and no abrading action occurred with a new belt. Similar evidence was apparent from films of the belt made after equivalents of three months' and six months' wear. However, after a 9 to 12-months' equivalent, the belt was stretched to the point where its vibration brought it in contact with the base of the casting, *Fig.* 3. These frames are consecutive and it

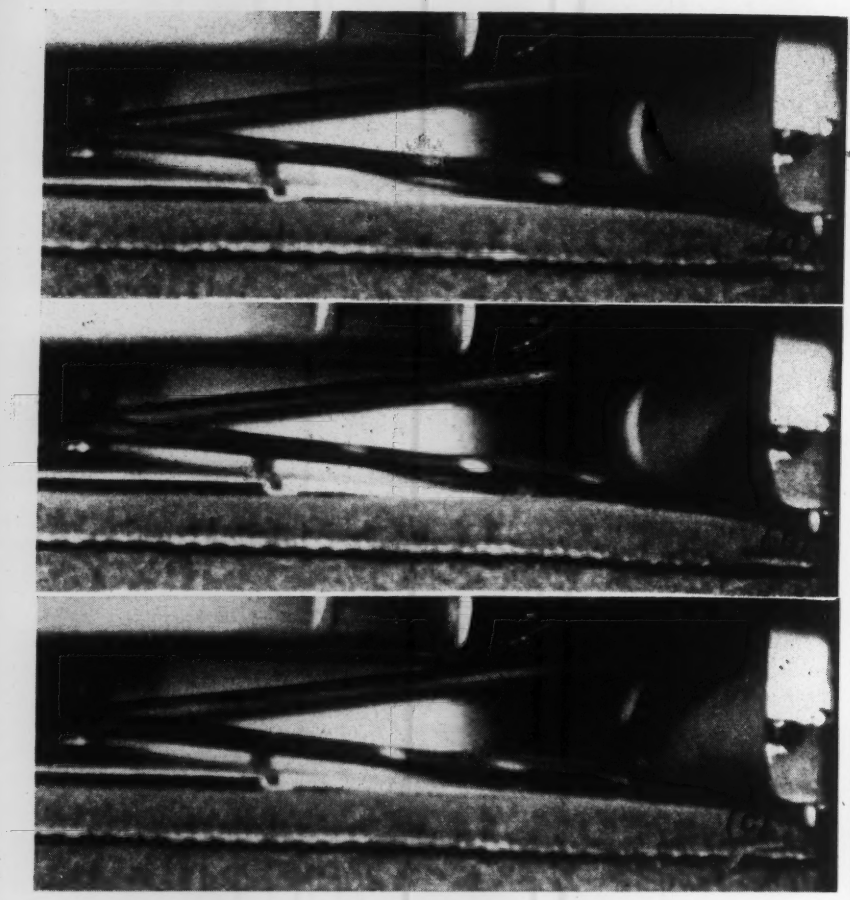
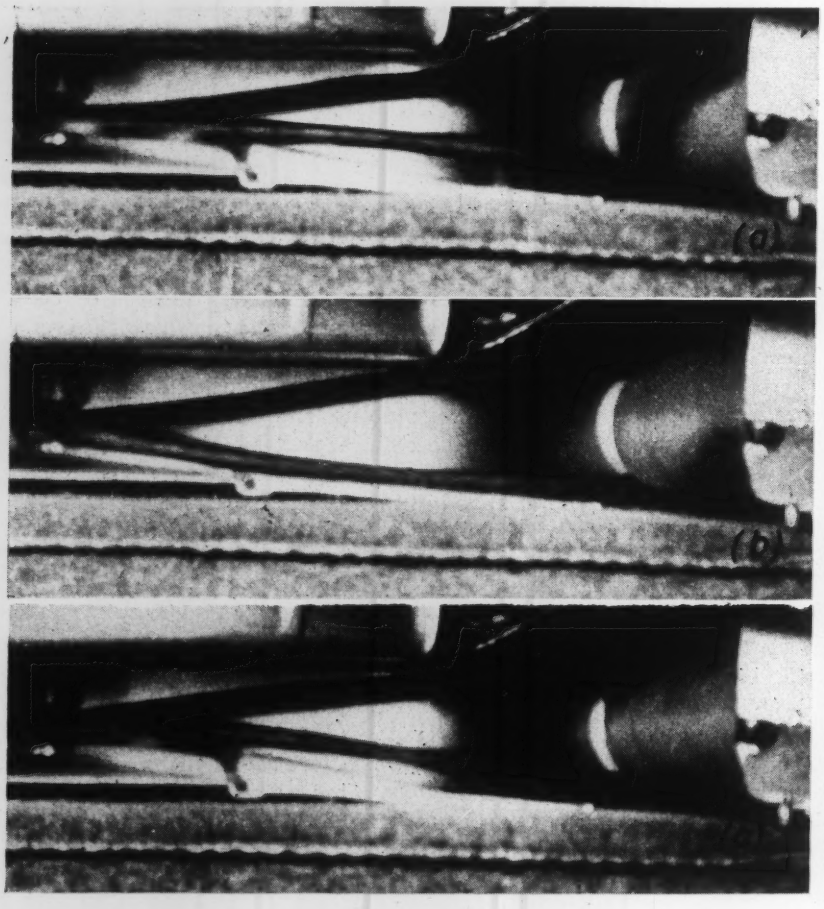


Fig. 2—Above—Consecutive frames (1/3000-second per frame) of a film of a new vacuum cleaner belt in operation. Vibration was not excessive; no abrading action was evident



was apparent that the belt was slapping against the casting at a considerable frequency. Because of the abrading action which resulted, the rate of wear increased rapidly during the final stages of the belt life. This caused slippage of the brush roll and a resultant decrease of efficiency of the cleaner.

Perhaps the most surprising information derived from a study of the motion pictures was that the vibration was greater on the drive, or tension, side of the belt. From a practical standpoint, however, Eureka engineers were more interested in the fact that clearance was wholly adequate until such a time as the belt became distorted from normal use. In view of this, tests were conducted to find a new type of belt material which would successfully resist distortion, prolonging the period of abrasion-free action. Several dozen compounds were tested before a final selection was made. The result is an increase in normal belt life of more than 100 per cent.

Incidentally, during the course of these motion-picture studies, Eureka's engineers noted that the amplitude of vibration of the rug offered a means of effectively measuring the "beater action" of the cleaner. While this action is not apparent in the enlargements as shown, it is quite visible when the pictures are projected on a screen. The engineers were able not only to measure the effects of slippage caused by belt wear, but also to determine the effect of bristles of different lengths and diameters. An analysis led to the adoption of three rows of bristles spirally mounted on the brush roll, each row differing in length, diameter, and stiffness.

ROTARY AIR PUMP: A second example of the influence of high-speed movies on the selection of materials is provided by the study of a rotary air pump used in low-pressure oil burner units, *Fig.* 4.

Fig. 3—Left—Same belt as in Fig. 2 after the equivalent of nine to twelve months' use. Belt was sufficiently stretched to bring it into contact with the base of the casting

As the rotor turns on its shaft, fiber vanes in each of six slots are driven by centrifugal force to sweep the walls of the pump housing.

Seeking to eliminate vibration from this unit, engineers who photographed the rotor expected to charge the fault to one of three possibilities: shaft whip, action of the vanes in their slots during rotation, or compression of the oil film inside the pump either at the point where the rotor is tangent to its housing or at the root of the vanes.

Despite difficulty in adequately lighting the rotor for exposures of less than 1/15,000-second, the motion pictures revealed that none of these theories were correct. Using a microfilm reader on which the 16-mm films were projected and measured a frame at a time, project engineers found no appreciable shaft whip. The fiber vanes were seen sliding freely in their slots without deflection while rotating. Only slight evidence of oil compression was found at the root of the vanes.

When these mechanical possibilities of vibration were eliminated, attention was turned to the materials used for the rotor and shaft. It was found by measurement of enlarged frames that the high ductility of the aluminum rotor resulted in the opening of the bore under the stresses of high-speed operation. A change in specifications was issued to replace the aluminum rotor with one of cast iron; this resulted in eliminating the vibration. In the examples cited, high-speed motion pictures led, primarily, to a change in materials. Quite possibly, the information obtained might have been secured by other methods, with comparable end results. However, the use of high-speed motion pictures undoubtedly eliminated time-consuming, trial-and-error experimentation.

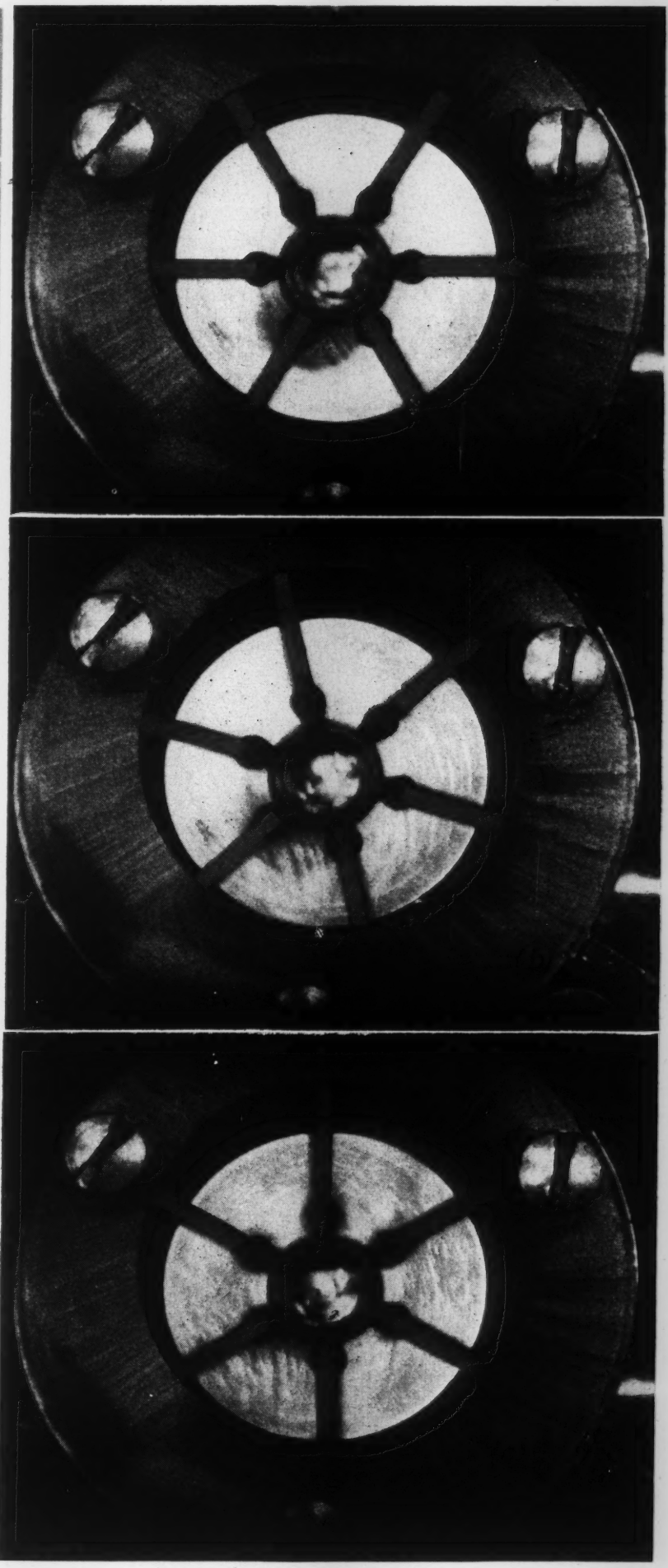


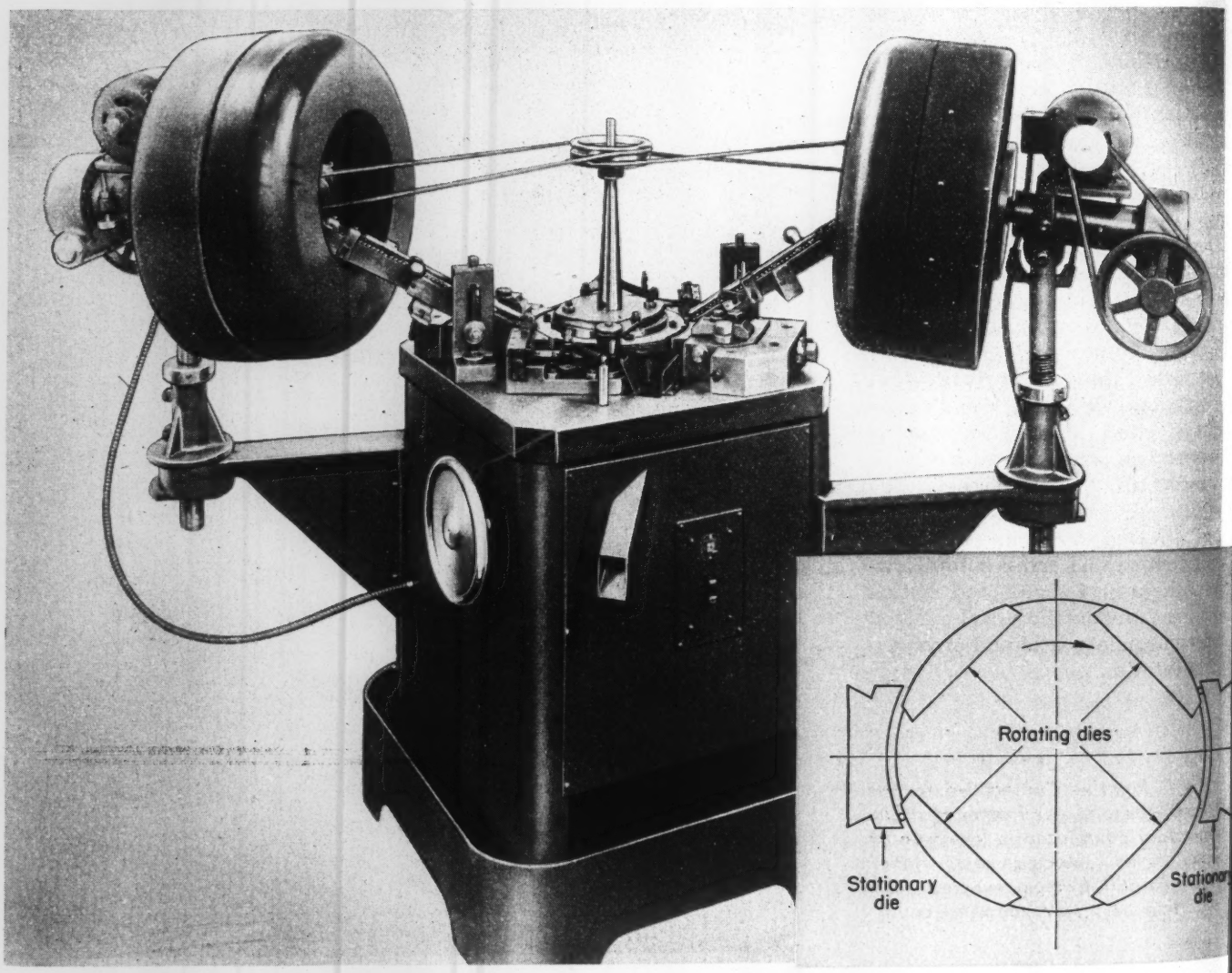
Fig. 4 — Right — Consecutive frames (1/15,000-second per frame) of a film of a rotary pump used in low-pressure burner units. Measurements taken from enlarged frames revealed rotor distortion as major vibration cause

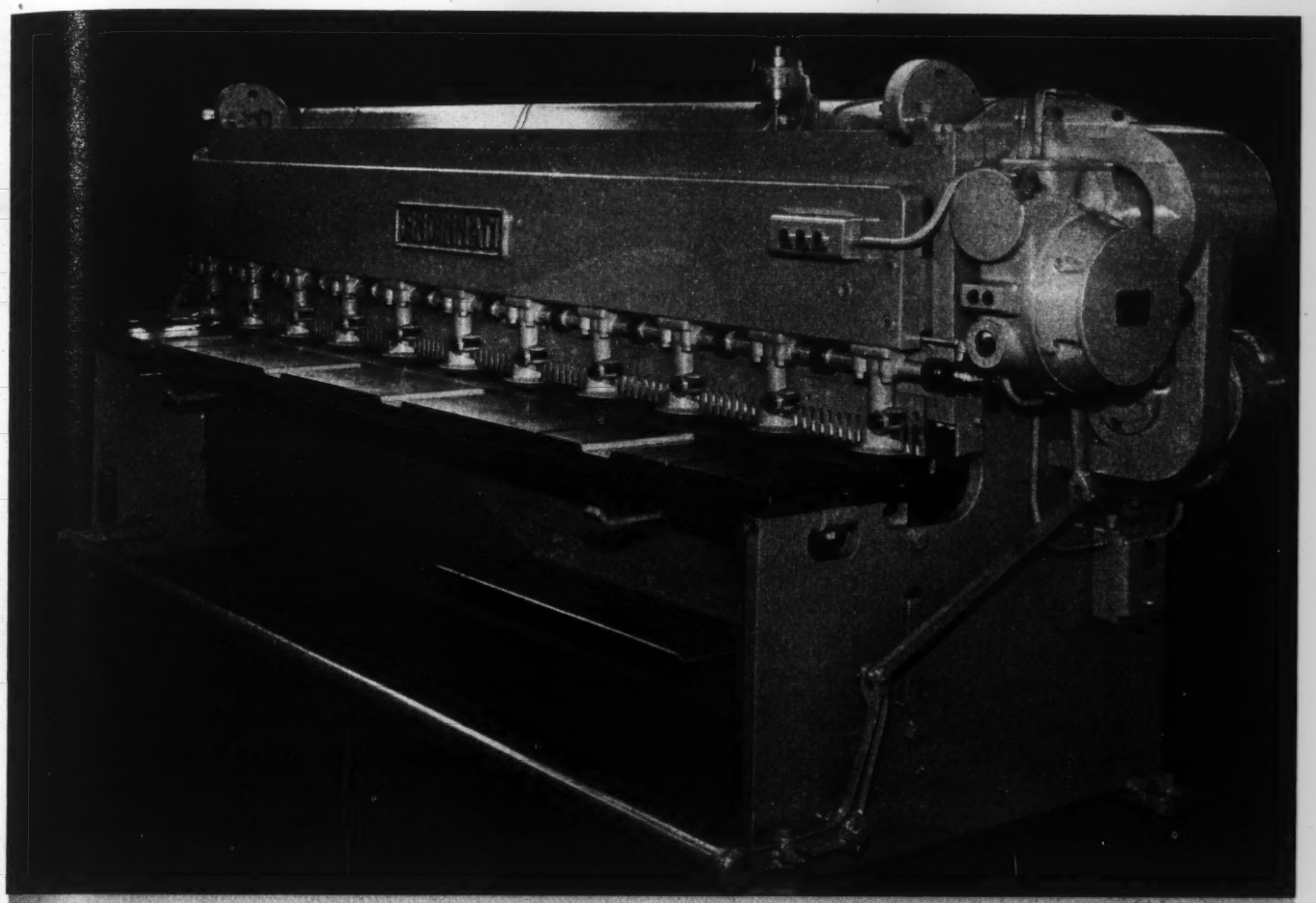
Contemporary DESIGN

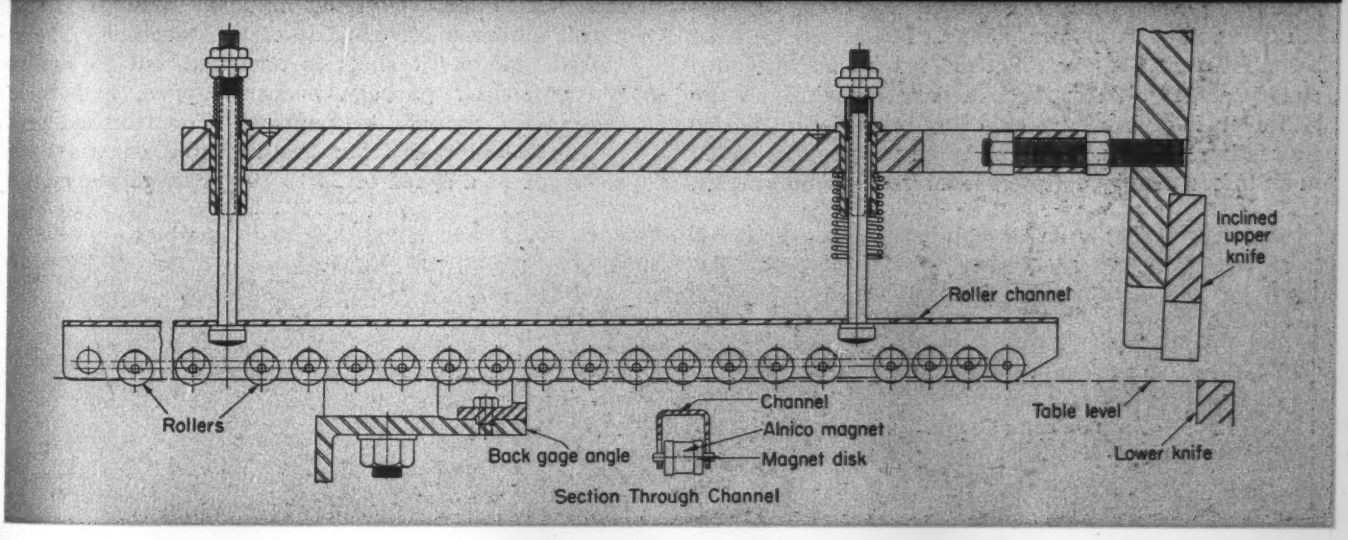
Thread Roller Employs Planetary Action

PLANETARY action between four rotating and two stationary dies in the D. H. Prutton Machinery & Tool Co.'s No. 120 thread-rolling machine, below, permits rolling up to 25,000 threaded pieces per hour. When rolling concentric, parallel grooves, the machine can produce 36,000 parts per hour. Each of the four moving dies, shown in the sketch, inset, below, threads one bolt against each stationary die per revolution, resulting in eight rolled pieces per cycle. The machine is designed to provide complete adjustability of the feeding mechanism with all adjustments accessible to the operator.

Parts are fed down inclined chutes from individually-driven rotating hoppers. A rejector wheel in each hopper, belt driven from a spindle on the rotating die, throws off any parts that are not properly aligned to enter the die. Feeding fingers, triggered by an adjustable cam mounted on the rotating die assembly, pick parts from the feed chutes for insertion between the dies at the proper instant.

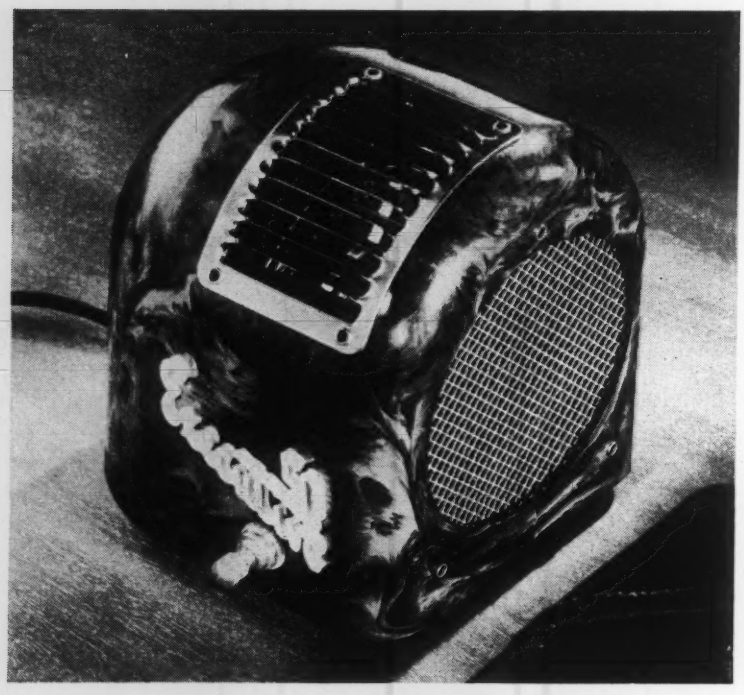






Magnetic Rollers Support Sheet on Shear

A SHEET support on the line of Cincinnati Shaper Co. shears, illustrated above, employs magnetic rollers to prevent the inaccurate back-gaging caused by sagging of stock during the cut. Support channels carrying Alnico permanent magnet rollers, as shown in the drawing above, are spaced along the length of the machine. The magnet rollers are free to turn in their supporting channels as the sheet is pushed into the shear, with no noticeable drag on the sheet. Cut pieces are automatically stripped from the magnetic support by action of the upper knife. The support is designed to handle all magnetic materials up to 16 gage thickness, with 36 or 48-inch back-gaging range. The shear shown in the photograph has a maximum capacity of 10 gage, 10 feet long. An inclined ram, straight-edge knives and hydraulic holddowns giving a uniform pressure the length of the cut also contribute to cutting accuracy.

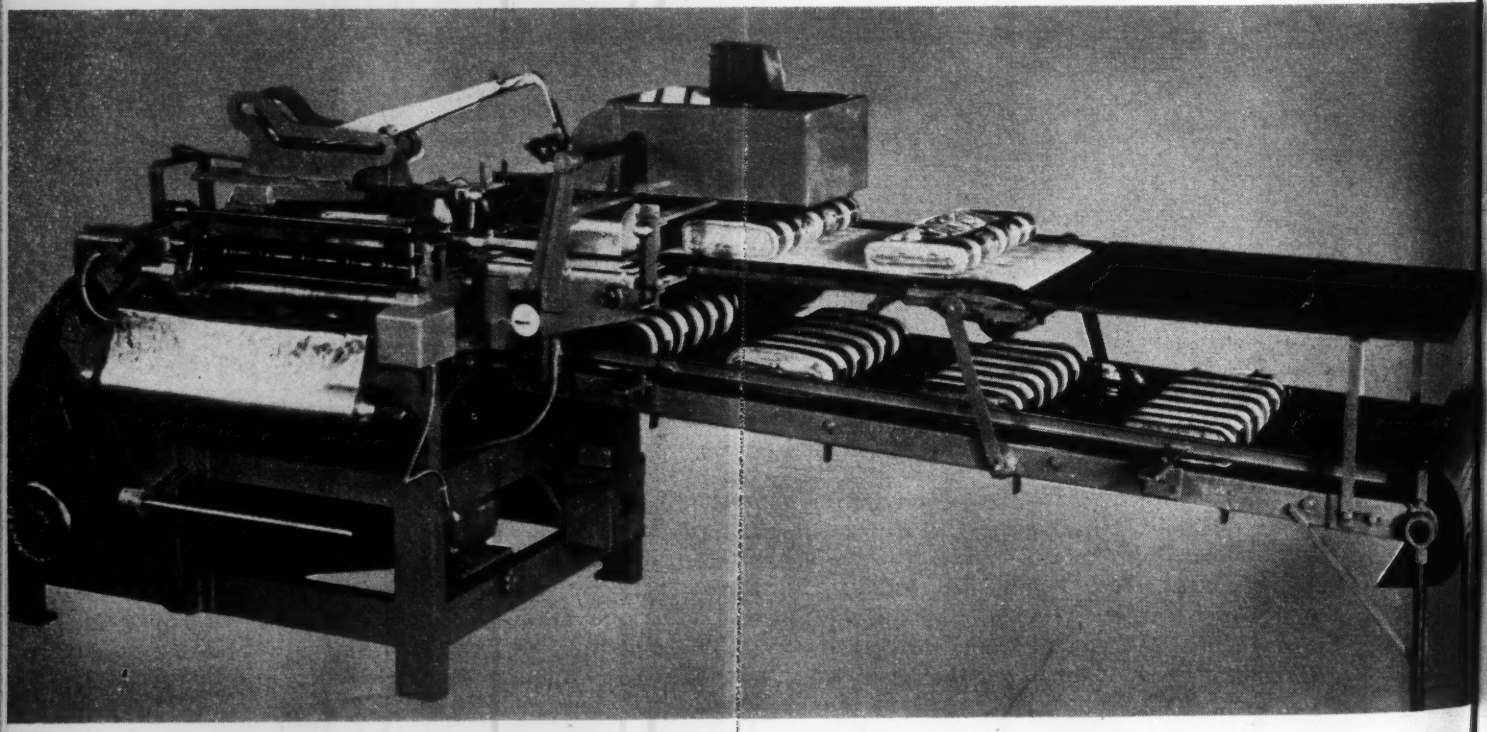


Office Air Circulator Fits Desk

A NEW concept in office air circulators, the National Reinforced Plastics Corp.'s portable fan, is shown in the illustration, left. The wheel type impeller provides a gentle air flow that will not disturb papers on the desk or cause gusts or drafts. Although equivalent to a 10-inch fan in quantity of air moved, the unit covers less desk area than a telephone, stands 5½ inches high and weighs 3¼ pounds. Modern case is of shatterproof Tenite.

Wrapper Automatically Packages Textiles

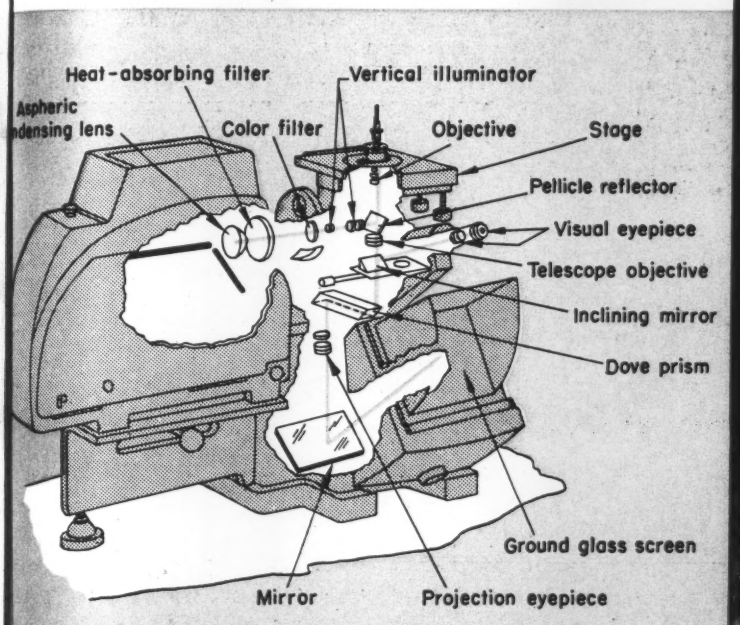
WRAPPING machine for automatic packaging of textile materials, using cellophane, polythene or pliofilm wrapping, is shown below. Made by Hayssen Manufacturing Co., the standard machine is designed for heat sealing. Other machines are available to wrap with acetate or kraft paper, using solvents or glue as the sealing medium. Material to be wrapped is loaded on an infeed conveyor (lower level in the photograph), with each package individually controlling the paper feed mechanism. Wrapping material is supplied from a roll mounted at one side of the machine. The required amount of sheet is unwound, cut to size for the particular package being wrapped, and folded and sealed around the package. The finished product is discharged from the machine on the upper conveyor at a speed of 20 to 30 packages per minute.

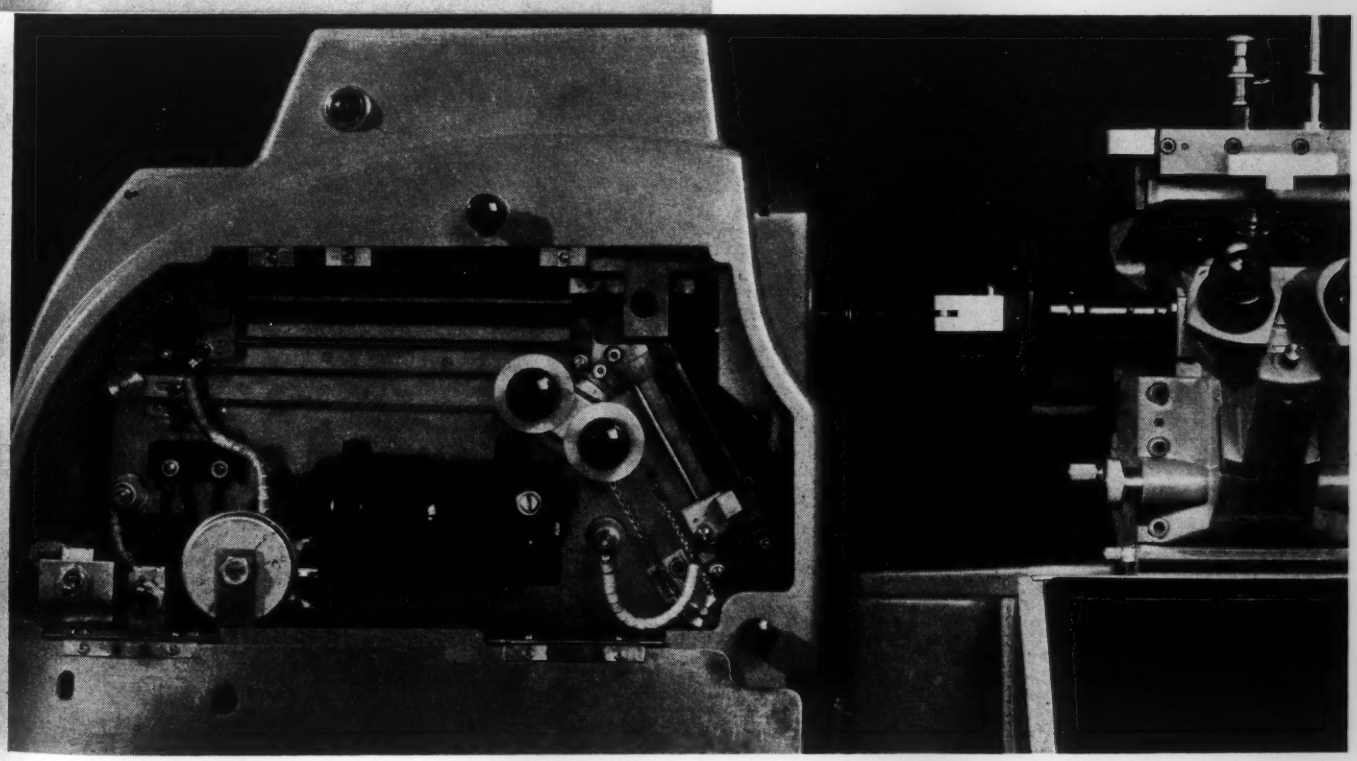


Metallograph Features Adjustable Carbon Arc

SUPERIOR optical performance is combined with convenience and simplicity of operation in the new Metallograph, right, designed for making routine photomicrographs for process-control purposes. Made by Instrument Division of American Optical Co., the equipment includes optical systems for photography and visual observation, coupled to permit all focusing to be done through the visual system, eliminating the necessity of ground glass focusing. The drawing, below, shows the path of light from a carbon arc lamp (or optional ribbon-filament lamp) to the visual eyepiece and viewing screen. Specimens are held in a mechanical stage mounted on ball bearings for smooth adjustability.

The housing of the carbon arc lamp has been opened in the photograph, bottom, to show the motor and drive for feeding in the carbon rods at a uniform rate to give the necessary steady arc. Adjusting





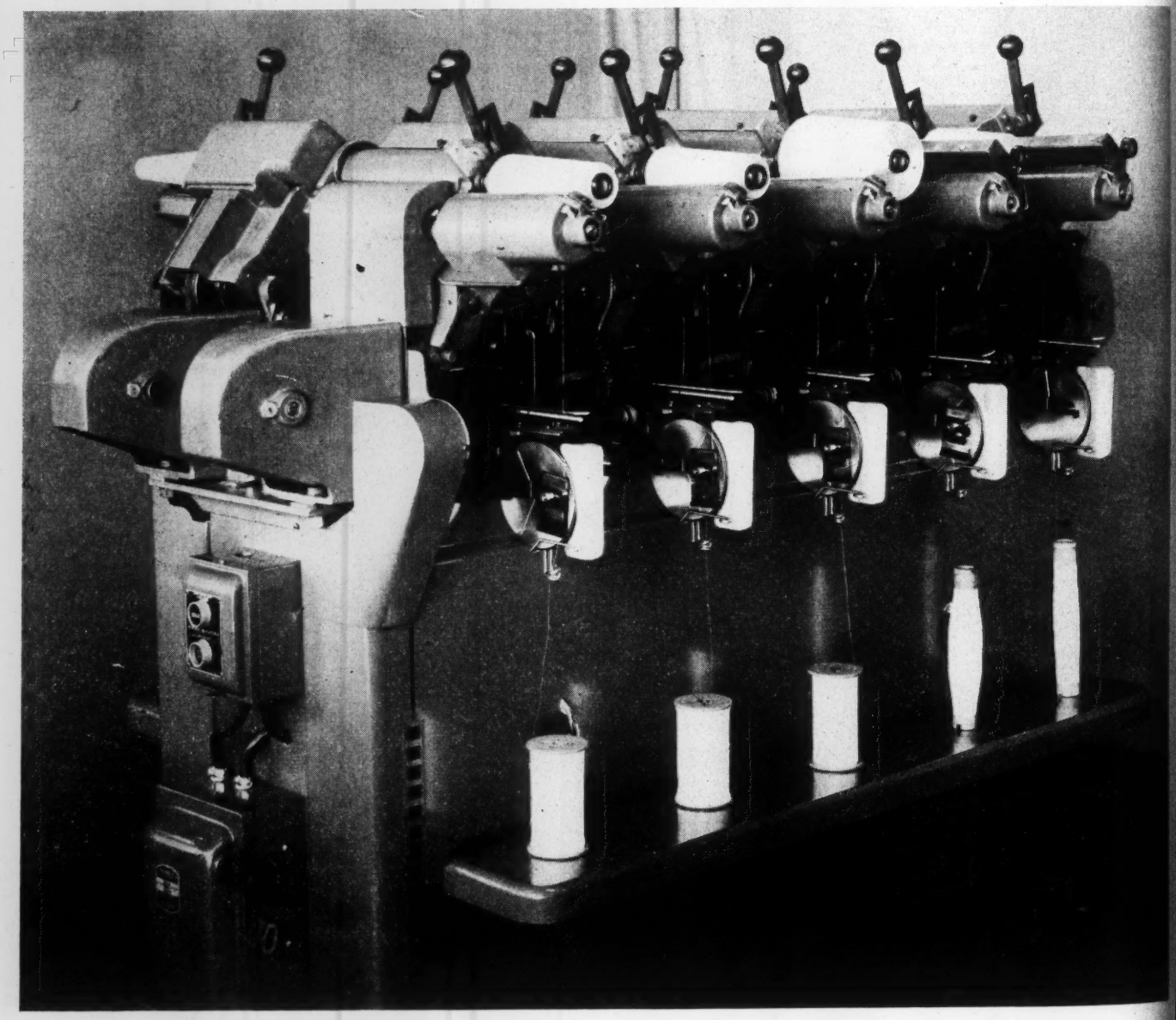
knobs provide for positioning the carbon arc unit laterally and in the vertical plane. The vertical rod is set at a 120-degree angle, which maintains a more uniform arc crater. A small glass viewing window permits an image of the arc crater to be seen, and a red warning light cautions the operator that the carbons are almost exhausted and that a new set should be installed before another picture is taken.

Standard magnifications are available in the range from 50X to 1500X, with four objective lenses carried in a revolving turret located just below the specimen stage. These lenses are all parfocal and parcentered, so that refocusing is not required when changing from one objective lens to another.

Thread Winder Uses Moving Spindle

REPRESENTATIVE of the swing of the textile industry to modern high-speed equipment, the precision thread winder, below, uses moving ball-bearing take-up spindles to wind at starting speeds of 400 yards per minute on a 3½-degree cone. Made by Universal Winding Co., the machine permits a straight thread line between supply and take-up spindles; during the course of winding the package moves horizontally relative to the thread guide. As the diameter of the package increases, the spindle frame is moved away from the thread guide by a builder cam. Speed of this movement is controlled by change gears selected according to thread size and, consequently, accurate density control is assured.

The tension device is a straight-line magnetic type equipped with a rotating plate which revolves at from 40 to 50 rpm, thereby lessening chances of clogging with most types of yarn. The machine can be built as a standard increasing-yarn-speed machine, as a constant-yarn-speed machine or as both combined.



FOR YOUR CONVENIENCE

A postcard is included in this editorial section to help you obtain clip sheets of any article in this issue. In this way you may file articles of special interest and still pass on *Machine Design* to the next reader without disturbing its editorial content.

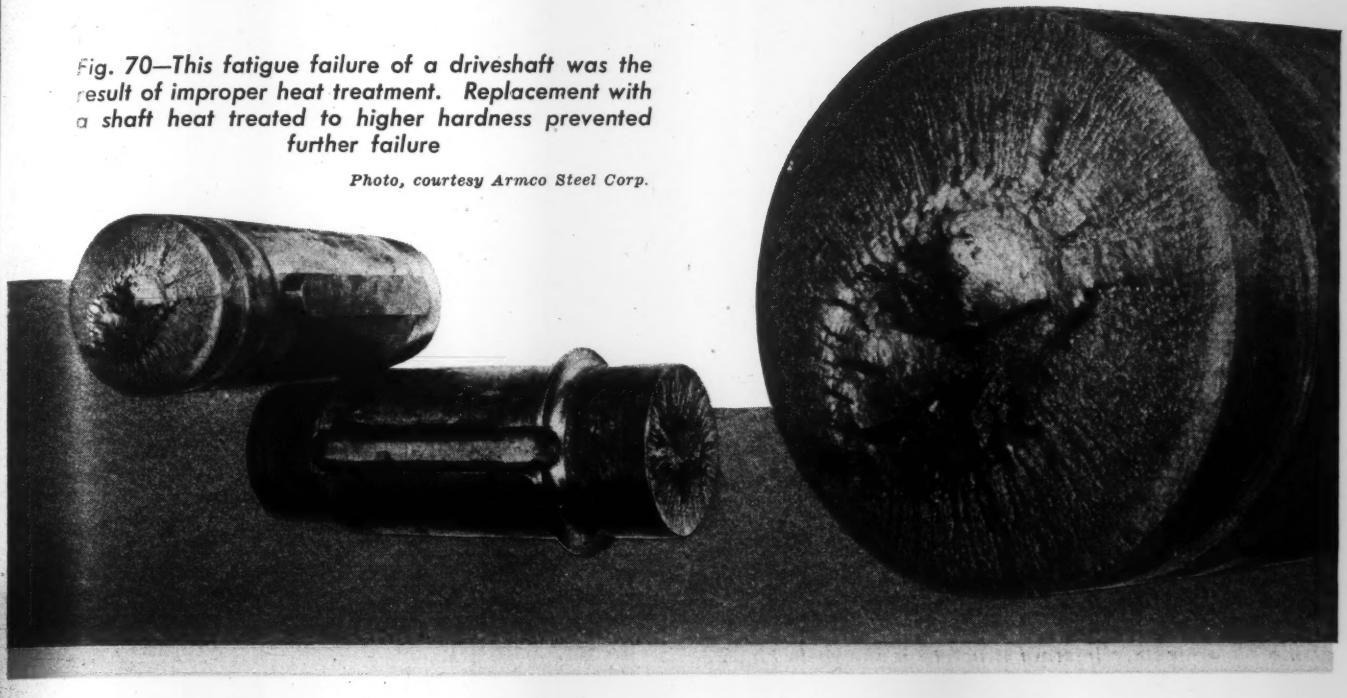


Fig. 70—This fatigue failure of a driveshaft was the result of improper heat treatment. Replacement with a shaft heat treated to higher hardness prevented further failure

Photo, courtesy Armco Steel Corp.

Why Machine Parts Fail

Part 8—When Not To Blame the Designer

By Charles Lipson
Consultant
Detroit, Mich.

LAST in the present series on fracture analysis, this article deals with failures caused by defective metallurgy, improper methods of fabrication and assembly, and other factors usually beyond the direct control of the designer. Failures resulting from defective design were discussed in last month's article.

Although fully 30 per cent of service failures in several representative industries have been attributed to the designer, the remaining 70 per cent can be traced to circumstances that are not his responsibility. Among these are such factors as improper heat treatment, accidental bruising of the finished part, substandard material, roughly machined surface, and various unexpected service conditions. *Fig.* 70 illustrates the fracture of a driveshaft from a spiral weld pipe machine. Although this fracture occurred at a small but sharp change in section, it was concluded that the underlying cause was failure to develop the full strength of the steel by proper heat treatment. No further failures have been reported since replacement with a properly heat-treated steel.

A number of the more representative failure causes, clearly beyond the control of the designer, and typical case histories are presented in the following discussion.

SURFACE DECARBURIZATION: Surface decarburization can be especially critical in leading to fatigue failures because the reduction in strength due to loss of carbon occurs where the stress is usually greatest—at the surface. This condition is probably most important in springs. In fact, it has been said that the relative superiority of certain alloys for springs, as regards fatigue properties, is based primarily on the superior resistance of such alloys to decarburization[1].

Thus failure of a member in an area of no evident stress concentration should not be dismissed lightly as overstressing when it may be a case of reduced surface strength due to decarburization. On a hardened steel spring, a relatively shallow layer of decarburization at the surface may soon develop fatigue cracks under repeated high stresses. The crack or

[1] References are tabulated at end of article.

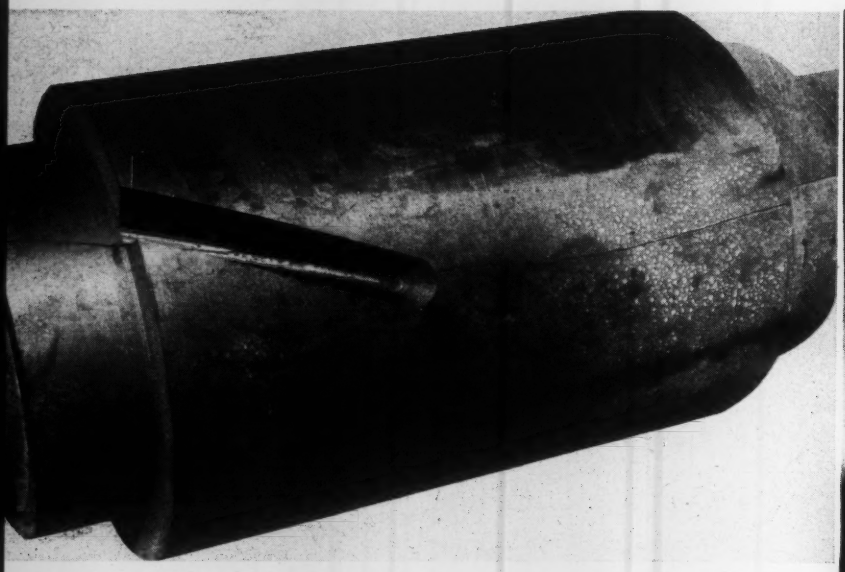


Fig. 71—Above—Improper heat treatment caused residual stresses which cracked this semimachined forging of a rolling mill drive pinion when the initial cut was made for the pinion teeth. Internal structure is shown in Fig. 72

Fig. 72—Right—This sectional view of the pinion shown in Fig. 71 reveals, by the absence of internal ruptures near the outer surface, that residual stress had not been relieved

Photos, courtesy Republic Steel C

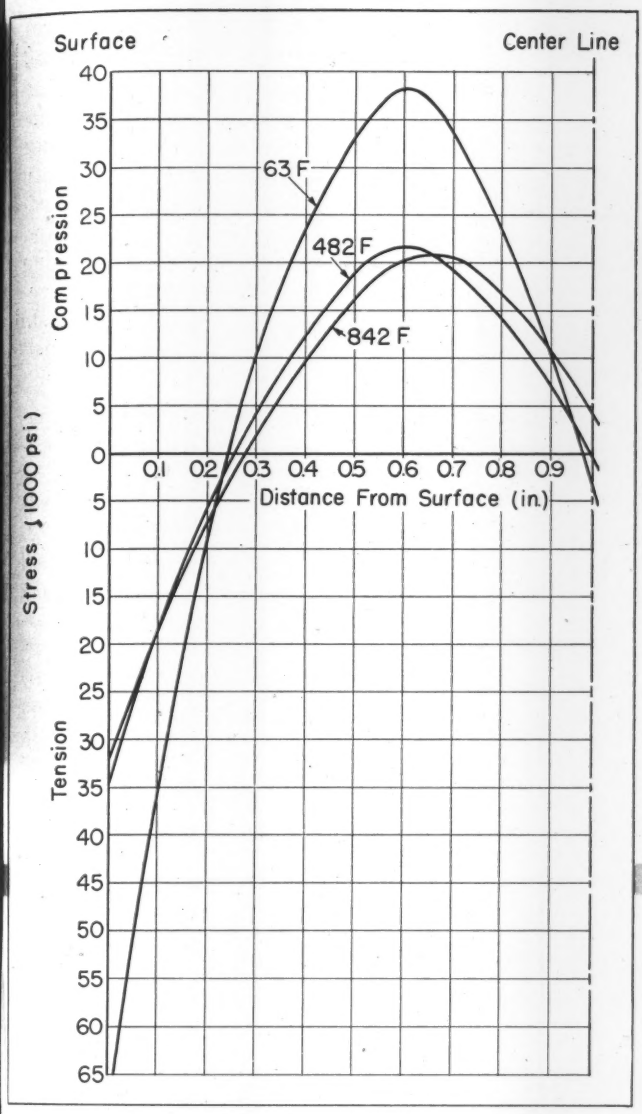
cracks then act as notches to cause stress concentration, with a resultant overloading of the full-strength material adjacent to the decarburized layer and, finally, fatigue failure. It should be kept in mind that a fatigue failure occurring in the immediate vicinity of an obvious design stress concentration may be due to both stress concentration and surface decarburization. This point is well illustrated in an article by McBrian and Archibald discussing failures in railroad track and cars[2]. Horger and Lipson also present data demonstrating the harmful effect of decarburization on the fatigue strength of automotive rear axle shafts[3].

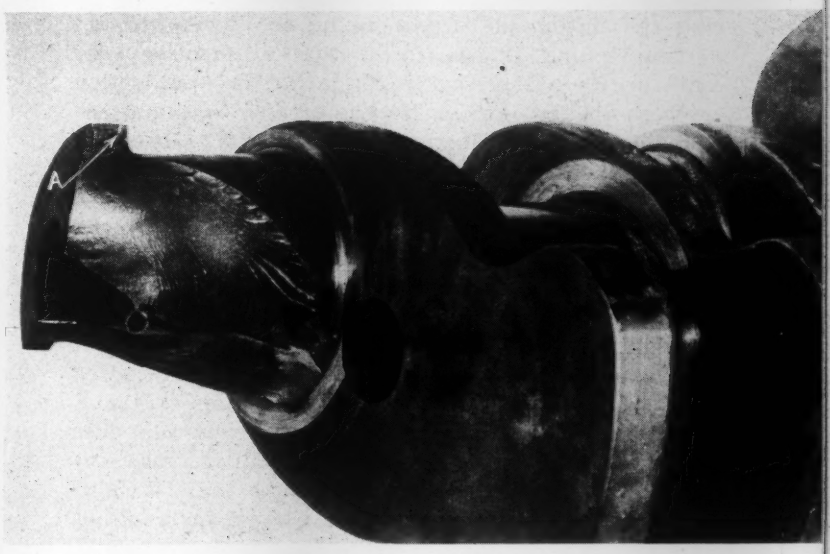
QUENCHING CRACKS: Among the numerous metallurgical factors that can precipitate fatigue failures, should be mentioned quenching cracks. These cracks, the result of drastic quenching, cause local stress concentrations and can, of course, lead to fatigue cracks and ultimate fracture. Scott found that it was possible to obtain quenching cracks in ¾ to 1½-inch diameter cylinders by water quenching[4]. Upon examination of fractured pieces, it may be quite difficult to determine whether the crack initiation was due to quenching practice, but in severely quenched pieces this possibility should be given full consideration. Failures from this cause can, however, be minimized by inspection of pieces, prior to placing in service, by the various crack-detection methods such as Magnaflux, Zyglo, and mild etching.

INCLUSIONS: Inclusions also represent structural discontinuities; those at the surface of the material are very much more detrimental in their effect on the endurance limit than inclusions deeper in the metal. The effect of inclusions is more serious as the hardness of the steel increases. J. B. Johnson was convinced that "large inclusions, or a cluster of many small ones, may reduce fatigue strength by about 15 per cent when the ratio of the depth of the inclusions in a radial direction to the diameter of the specimen is approximately one to ten"[5]. Evidently inclusions are most dangerous when located at fillets or other highly stressed locations. When a fatigue crack starts, it tends to progress from one inclusion to another. There is a natural tendency to ascribe any fatigue failure to inclusions if metallographic examination reveals an inclusion anywhere in the piece, no matter how far the inclusion may be from the nucleus of failure. Tiny inclusions often present in well-made steels have only about the same effect as a surface scratch of the same dimensions. Inclusions in general are much less serious than such stress raisers as meager fillets, oil holes and other geometric discontinuities.

Inclusions Less Significant in Soft Steel

As with other defects, discontinuities in a metal are more serious the harder the steel. Extreme cases have been observed where inclusions are held responsible for dropping the endurance limit of a hard steel from 80,000 to 64,000 psi. In soft steels the effect of ordinary small inclusions is very slight. For these reasons "dirty" steel should be avoided particularly for use in hard, highly stressed parts.





Photo, courtesy International Harvester Co.

Fig. 73—Left—Effect of straightening temperature on residual stress for heat-treated parts is shown by this graph from Reference 9

Fig. 74—Above—Fatigue failure of this crankshaft was caused by a grinding crack indicated by (A). Combination of a grinding crack and a fillet is an almost certain fatigue failure source

The slag inclusions sometimes found in welds can also be detrimental to the fatigue properties of parts fabricated by this method.

CASTING DEFECTS: Castings are subject to several defects, associated with the casting process, that can lower the strength of the material, either locally or generally, below the calculated level. Blow holes, shrinks, hot tears and cracks, and inclusions are just a few of the imperfections apt to be encountered. The American Foundrymen's Association has compiled a detailed analysis of the common casting defects, including a study of the factors that produce each, as well as many illustrations for the identification of these defects[6]. The AFA analysis finds that most casting defects can be attributed to the pouring operation with molding practice, cores, and sand each following closely behind as major factors in causing poor castings. Approximately 9 per cent of the casting defects found were attributable to the designer.

HOT SHORTNESS: Steel can become *hot short*—brittle at temperatures of 475 F or higher—due to the absorption of copper and other metals. Williams cites an interesting case of this type in which fatigue fracture was originated by a sudden surface crack to the depth of copper penetration[7]. This crack then propagated itself under the imposed repeated stresses until complete failure occurred. There was no indication of flaws in the material, but a metallographic study indicated absorption of copper at the surface.

RESIDUAL STRESSES: Presence of residual stresses in the finished piece, due to heat treatment or fabrication methods, can be either harmful or beneficial to the fatigue life of a machine part. Residual tensile stresses can manifest themselves in either mechanical or chemical effects. Mechanically, cracking or warping of the part is caused. Chemically, grain boundary corrosion is caused and may result in complete loss of boundary cohesion. Much research work on residual stresses has given some knowledge of how and why they occur and means of measuring their intensity. In examination of a fracture, however, there may be little evidence pointing to the existence of a residual stress. It is then necessary to study the history of the part from the ingot to the finished piece. Heat treatment (including quenching practice), drawing or rolling, cold working, cold straightening, and other fabrication processes may all result in residual stresses.

Occasionally residual stresses due to heat treatment may be sufficient to cause a perceptible crack before the part is ever placed in service. An example of this circumstance is the rolling mill drive pinion pictured in *Figs.* 71 and 72. Residual stresses in the heavy section apparently were instrumental in causing the stress crack which developed and spread dur-

ing the initial cut in machining the pinion teeth.[8]

Horger and Lipson found that automotive rear axle shafts cold-straightened during the production process demonstrated a 25 per cent loss of endurance limit compared to unstraightened shafts[3]. In evaluating the magnitude of residual stresses induced by cold straightening, they observed residual surface tensile stresses as high as 120,000 psi. It has been found, as illustrated in *Fig.* 73, that the severity of residual stresses induced by the straightening operation varies with the temperature at which the straightening is done[9]. This plot demonstrates that the magnitude of residual stresses can be reduced 50 per cent by performing the straightening at 482 F instead of at room temperature. However, this does not mean that the fatigue strength will increase correspondingly. The plot also indicates that straightening at temperatures above 482 F gives insignificant improvement.

Residual Stresses Most Harmful in Hard Steel

As with many other factors, the weakening effect of residual stresses is much more pronounced for hard brittle steels than for ductile steels. Through their inherent plasticity, ductile steels are capable of internal stress relief upon cyclical load application.

TOOL MARKS: It is common knowledge that rough machining can often initiate fatigue failure in highly stressed machine parts. Each groove left by the cutting tool acts as a stress concentration and becomes a candidate for the nucleus of a fatigue crack. This effect is intensified if a generally smooth surface is marked by a few isolated tool marks. The presence of a multiplicity of similar stress concentrations, as in a threaded part, has a slightly alleviating effect. Because endurance limit increases with improved surface finish, surfaces of severely stressed aircraft parts are usually highly polished.

Close examination of the fractured part may sometimes be necessary to detect a tool mark as the cause of failure. The surface in general might be smooth with only a single deep tool mark that probably coincides with the plane of the fatigue fracture and loses its identity upon fracture. Rough machining is apt to be most dangerous in fillets and other regions where some stress concentration already exists and is, of course, most critical in hard notch-sensitive steels.

GRINDING CRACKS: Cracks in otherwise sound material can also be caused by severe grinding operations. These cracks, once formed, naturally act to decrease the fatigue strength of the part. The heat and pressure resulting from contact of grinding wheel and steel may be sufficient to cause either residual stresses or actual cracks. In hardened steels, cracks may be the result of proper grinding of an improperly heat-treated part, or of improperly grinding a correctly heat-treated part. Surface cracks arising during the grinding process are most prominent and most harmful in hardened steel. Formation of grinding cracks varies with composition and hardness of the steel being ground, surface speed of grinding, rate of material removal, and various factors involved in the structure of the grinding wheel.

Shown in *Fig.* 74 is a crankshaft fatigue failure which originated at a series of grinding cracks in the fillet region. At *A* in the illustration is the grinding crack which was the nucleus for the fracture.

Tarasov points out that in spite of their comparative shallowness (often not more than 0.0005-inch), cracks in a ground surface can rarely be removed in

Fig. 75—Comparison of endurance limits for as-forged surface with ground and polished surface is shown in this study by Lipson and Noll

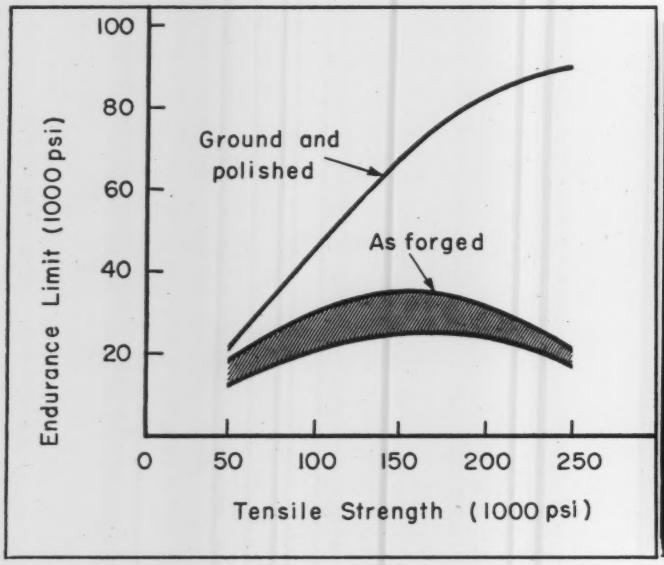
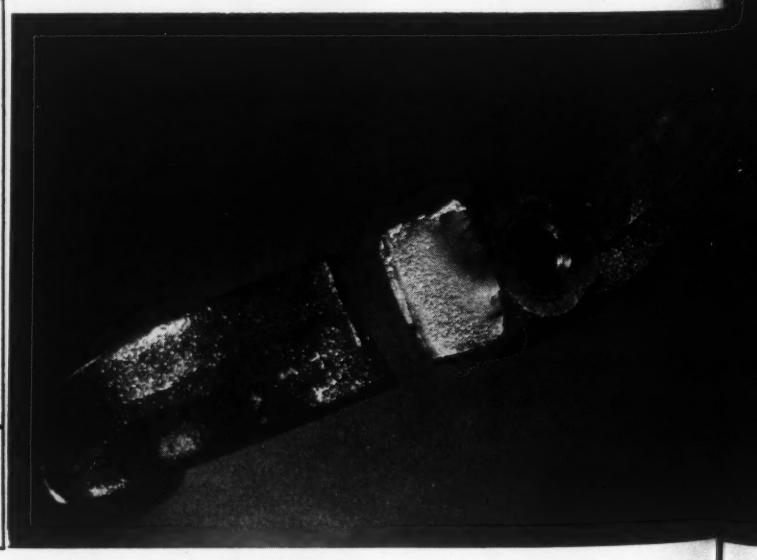


Fig. 76—Failure of this steel forging during fatigue test was caused by the rough decarburized surface in combination with the sharp corner

Photo, courtesy Ford Motor Co.



ordinary practice, either because of insufficient stock left for grinding below the crack bottoms or because the cracks keep propagating themselves deeper while they are being ground away[10].

ROUGH SURFACES: Rough surfaces on machine members, such as those left on unfinished forgings, are detrimental to fatigue strength. The endurance limit of such a part will be considerably below that for the same steel in the form of a smoothly polished laboratory test specimen. The accompanying graph, *Fig.* 75, demonstrates the reduction of fatigue strength associated with an as-forged surface compared to a polished surface.

Several Faults May Be Present

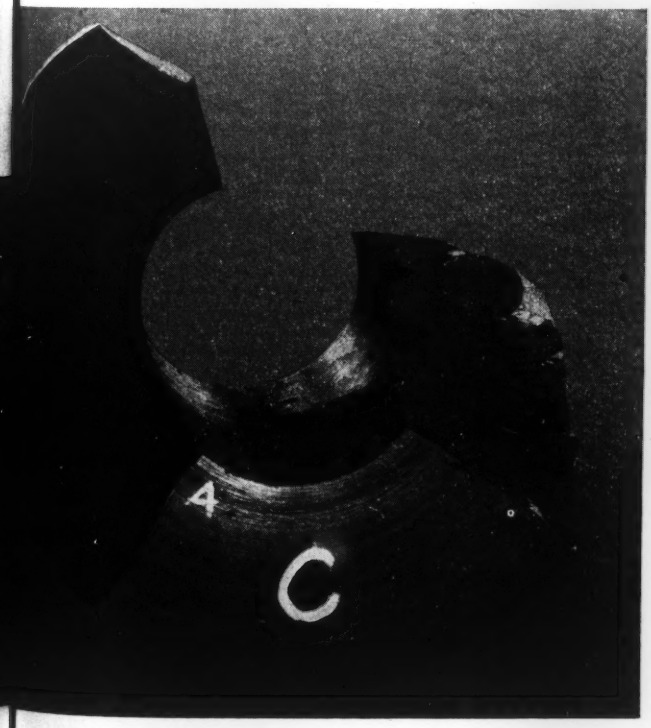
The harmful effect of the as-forged surface is actually due usually to a combination of such factors as roughness, oxide scale defects, and surface decarburization. Inadequate fillets, sharp external corners and other geometrical stress raisers will serve to amplify the effect. *Fig.* 76 is a photograph of a forged arm which failed in fatigue. It is evident that the rough forged surface, in combination with the sharp corner at the edge of the flat surface, contributed to initiation of the fatigue crack.

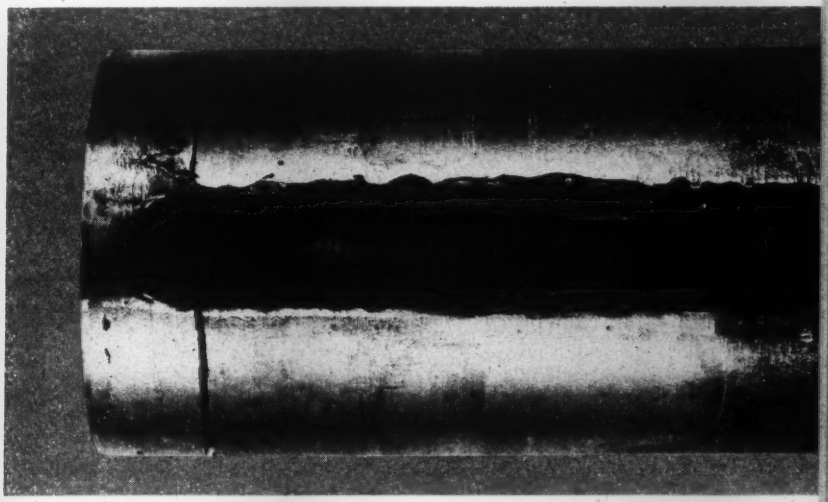
FORGING DEFECTS: Common defects inherent in the forging process, including such phenomena as forging bursts, pipes, laps and seams, all act as discontinuities and, hence, local stress concentrations. If these occur near the surface, as seams and laps often do, the effect is especially pronounced in reducing the fatigue strength of the part. Forging of shanks on large masses of steel should be smoothly done where sections change in size. Sharp local depressions and roughly finished radii act as seeds for the initiation of fatigue cracks. Any fractured piece with surfaces left in the forged condition should be inspected carefully with these facts in mind.

Illustrated in *Fig.* 77 is the failure of a steamship paddle-wheel drive shaft. This shaft had been in service for approximately 10 years when an audible "squeaking" was noted. Examination revealed a large spiral-shaped crack on the surface of the shaft extending for a considerable length. The crack was multiple in nature with loose pieces between the cracks.

The shaft was a large forging of plain carbon steel, approximately SAE 1040, and had been liquid quenched. Further examination showed numerous radial cracks, with the fractures covered with rust, extending from the center outward to within 2 to 3 inches of the surface. There were also indications of decarburization along the borders of the rusted portion of the fracture, from which it can be assumed that the cracks were present at high temperature. Although the steel contained a large amount of nonmetallic inclusions it was felt that the failure was initiated at the time of fabrication by a secondary pipe in the ingot.

WELDS: It has been said of welded joints that they are subject to almost all types of stress concentration that can be thought of in relation to ordinary design plus some of their own. Although a great deal of work has been done in studying the stress concentrations that often accompany the welding process, poor welding practice is still by far the chief cause of failure of welded assemblies rather than any stress concentration associated with the weld geometry. Weld defects may be in the form of internal voids, rough beads, large slag inclusions, lack of fusion, and shrinkage cracks, to name just a



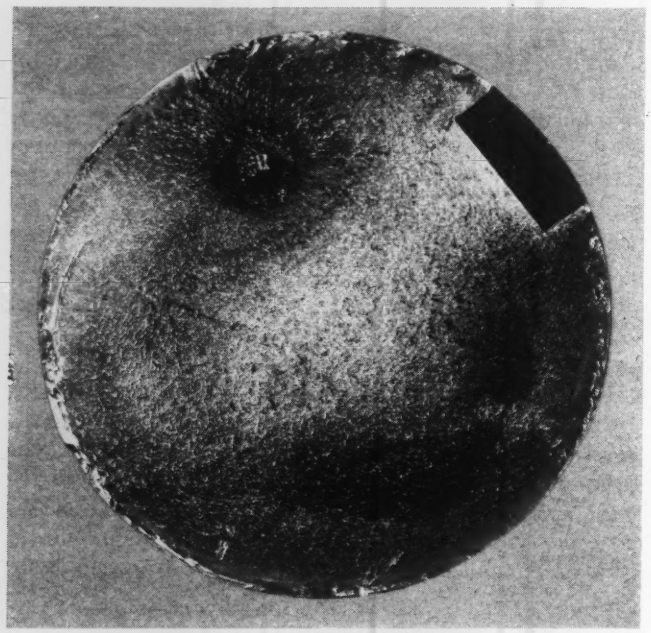


Photo, courtesy Republic Steel Corp.

Fig. 77—Left—Torsional fatigue failure of this steamship shaft was caused by forging defects. Many radial cracks resulted from a secondary pipe in the ingot

Fig. 78—Above—This undersized shaft was salvaged by welding. Improper heat treatment after welding gave a brittle peripheral zone which caused the fracture

few. Particular attention should be paid to the rate of cooling after welding if the steels being welded are capable of air hardening; otherwise a very brittle martensitic structure may result in the vicinity of the weld. This latter point is illustrated in *Figs.* 78 and 79 which show a rolling mill lineshaft failure. This shaft had been built up by welding after having been machined too small in diameter. The heat of welding had been extracted from the weld at a rate sufficient to produce a 3/16-inch deep peripheral martensitic zone. As indicated in *Fig.* 79, the fatigue failure apparently originated at several points in this outer zone and progressed rapidly through the shaft. The fracture surfaces gave no evidence of internal defects in the steel.

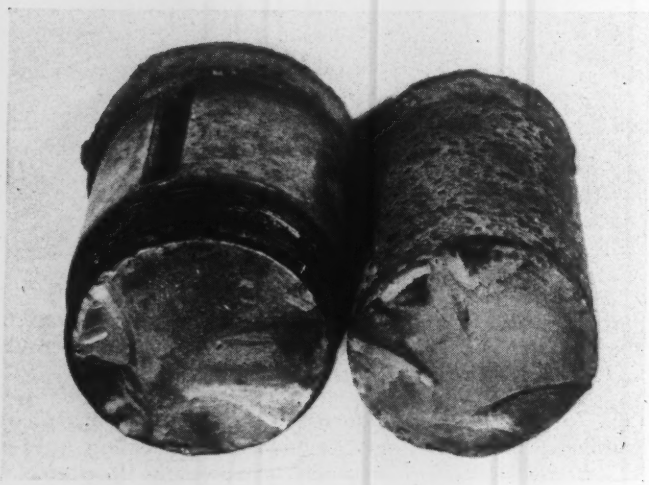


Photo, courtesy Republic Steel Corp.

Fig. 79—Above—This fracture surface of the shaft shown in Fig. 78 reveals that, even though a stress-concentrating keyway is present, fracture started around the entire surface of the part

Fig. 80—Below—Fatigue failure of this shaft occurred through a section left brittle by a weld applied to compensate for previous wear

Photo, courtesy Armco Steel Corp.



SALVAGING OPERATIONS: Many times, in the process of repairs or modifications in the shop, insufficient attention is given to stress considerations. It often happens that these changes do not pass through the engineering department. This process may lead to failures because of lack of appreciation of the many small details in fabrication that can lead to critical stress concentrations or residual stresses.

Failures Due to Salvage by Welding

Many parts are salvaged by welding: joining the two halves of a fractured part or building up material to replace that removed by wear or by a machining error. Several failures have been encountered in which injudicious welding practice during the salvaging operation was primarily responsible for subsequent failures[1].

In *Fig.* 80 is illustrated the fracture of a well-pump shaft attributed to rapid cooling of a welded area. This ½-inch diameter shaft broke after 8 years of service in a centrifugal deep-well pump. The failure occurred at a point where the surface had been built up by weld deposits because of wear in a previous service period. The material was plain carbon steel with a microstructure indicating that the shaft had been normalized. The hardness varied from 160 bhn in the base metal to 240 bhn in the weld deposit and the zone affected by the heat from welding.

Lack of fusion, defects in the deposited weld metal, use of improper welding electrodes, and other examples of poor welding practice are frequently found to promote fatigue failures through reduction in the strength of the material or the introduction of cracks or residual stresses.

Many other factors beyond the province of the designer could be given as potential causes of failure, such as corrosion, heat checks, unsuspected resonance vibration, etc. A large number of influences are listed in Reference 1. Thus, identification of the cause of failure of a machine part may be a simple task or a difficult one, depending on the multiplicity of influences. One point stands out clearly. A fractured machine part deserves respect.

REFERENCES

1. *Prevention of the Failure of Metals Under Repeated Stresses,* Battelle Memorial Institute, John Wiley & Sons, New York, 1946.
2. Ray McBrian and P. A. Archibald—"Railroad Failures in Track and Cars," *Metal Progress,* Aug., 1941, Pages 189-191.
3. O. J. Horger and C. H. Lipson—"Automotive Rear Axles and Means of Improving Their Fatigue Resistance," Symposium on Testing of Parts and Assemblies, ASTM, 1946.
4. H. Scott—"Origin of Quenching Cracks," *Scientific Papers of Bureau of Standards,* Vol. 20, Pages 399-444, 1924-1926.
5. J. B. Johnson—"Magnaflux—What Does It Show," *SAE Journal,* Vol. 44, 1939, Pages 346-352, 381-388.
6. *Analysis of Casting Defects,* American Foundrymen's Association, Chicago, 1947.
7. F. H. Williams—"Car Axle Failures Traced to Absorption of Bearing Metal," *Product Engineering,* Aug., 1944, Page 505.
8. S. W. Poole and R. J. Johnson—"A Review of Some Mechanical Failures of Steel Plant Machine Equipment," *Proc. SESA,* Vol. III, No. 2, 1945, Page 61.
9. N. N. Davidenkox and E. M. Shevandin—"The Study of Residual Stresses Due to Bending," *Jour. Tech. Phys.,* Vol. IX, No. 12, USSR, 1939; Ministry of Aircraft Production Trans. No. 1803.
10. L. P. Tarasov—*Detection, Causes and Prevention of Injury in Ground Surfaces,* American Society for Metals, Cleveland, 1945.

PRODUCTION AND DESIGN
Modern Practices in Manufacture

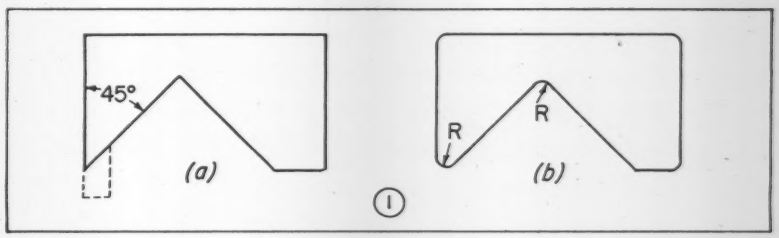
DESIGN DETAILS

for Stamped Parts

By Dayton A. Rogers
President
Dayton Rogers Manufacturing Co.
Minneapolis, Minn.

Specifications of Flat Stampings

AS A STAMPING is shown on a drawing, it is commonly understood that the burr side is up, unless otherwise specified. Quite often it is important that the burr side be specified on the individual part drawing. This is not necessary, however, should the stamping be of such design that it can be turned over to give the burr side the correct position when the piece is assembled.



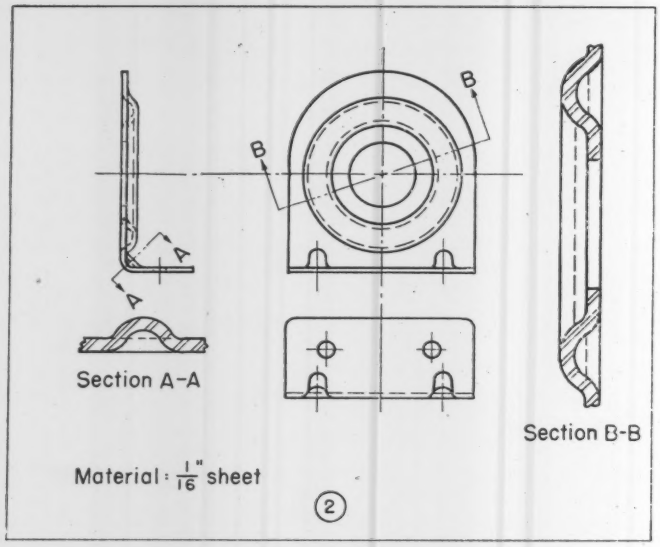
While parts *Fig.* 1*a* and *b* are essentially the same, should design permit, there should be a slight radius on all corners. This would increase the die life considerably, with the possibility of adding to the general appearance when the piece is used in the assembled unit. It is considered impractical to attempt a sharp corner as in *Fig.* 1*a*. This would shorten the punch life considerably and give an unsatisfactory finished section, particularly if the blank had any thickness whatsoever.

Should a sharp section be necessary on a finished blank, the blank could first be produced as shown by the dotted lines, and a second operation added to remove the excess material to give the finished blank the desired shape and size. With the short-run stamping method, an individual blanking die would be produced to make either *Fig.* 1*a* or *b*, and no universal tooling would be used. This of course would make it possible to produce the blank as at *b* with any desired radii or contour without additional cost.

Stamped Re-enforcing Ribs

WHILE re-enforcing ribbing or stiffening ribs in stampings are not new, sometimes their possibilities are overlooked in part design. It is generally found in a bent sheet-metal part, where it should be the stiffest, it is usually the weakest. One or more stiffening ribs, such as section "A-A" *Fig.* 2, at the right-angle bend increase the rigidity of the part about 100 to 200 per cent. Such ribs or corrugations can be twice the thickness of the material in their overall height, and the inside radius of the rib, if design permits, should be equal to the stock thickness.

Quite often, the large hole shown is merely introduced to lighten the part. However, should the hole be for a definite design purpose, a corrugation or rib ("B-B") may be easily thrown around the

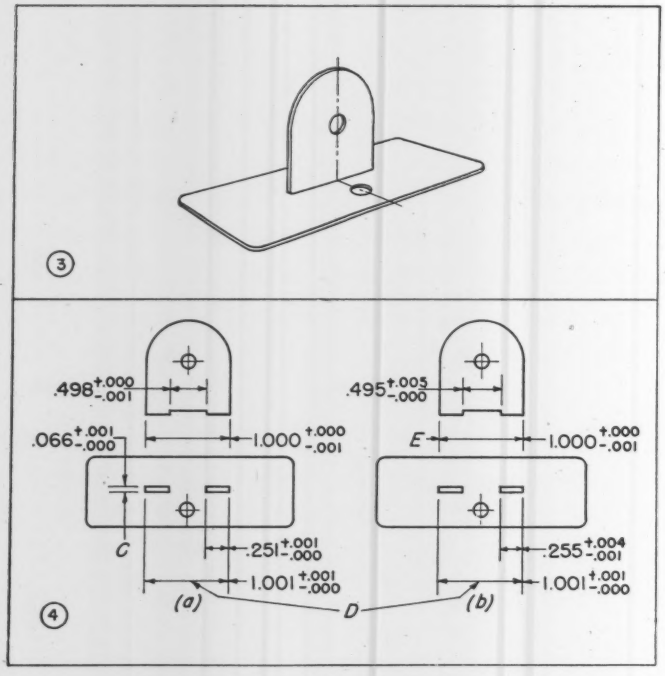


hole halfway between the outside of the piece and the hole.

Such ribbing and corrugating on parts should not be too close to the periphery of the blank; otherwise, there is a possibility of distorting the profile or contour. All such corrugation and ribbing should be as far as possible from the profile of any of the pierced holes or contour of the blank itself. This is due to the fact that the contour of the blank is first produced, the holes pierced in the second operation, and the ribbing and corrugating, including overall forming put in as later operations.

Production economy can be attained in design by keeping the ribbing and corrugating as far as possible from the pierced holes and blank profile and, in addition, least distortion of both holes and profile during forming operations is best assured.

Tolerance Specifications on Mating Parts



TWO die-cut parts completed the assembly shown in *Fig.* 3. It was most important, however, that the two holes in these parts, after assembly, be as accurate as possible and in perpendicular alignment. In the production of these two parts, the only close tolerances which had to be held were dimensions *C, D* and *E, Fig.* 4.

Specifications as first submitted, *Fig.* 4*a,* do show rather close tolerances. But tolerance accumulations would cause some discrepancy in the relationship of the two holes after assembly. *Fig.* 4*b* shows relatively the same two parts with more generous clearance in the mating of the two pieces before final assembly, but still maintaining the same relative accuracy and tolerance as to hole alignment. With the latter specifications, these two parts were staked together with the desired degree of accuracy at considerably less cost.

In dimensioning stamped parts, observation of this principle will assure maximum production economy. All dimensions should be studied to permit maximum latitude. Only those absolutely necessary should be specified with the minimum practicable limits.

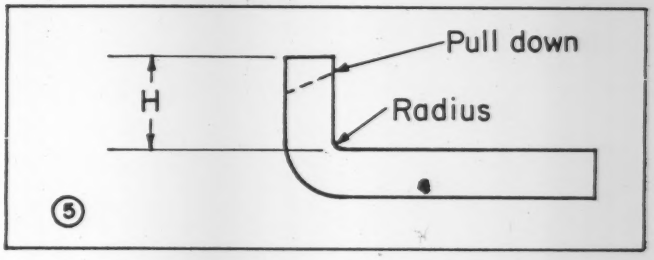
V-Form With Minimum Material Margin Or Minimum Height

IT IS OFTEN desirable to produce a given formed part with minimum overall height on the right-angle formed section. As simple as this operation appears, the overall right-angle bent section has limitations as to its height. Depending upon the material thickness, material temper, and physical properties of the sheet alloy being bent, the following are suggestions to be considered as minimum on such operations.

Minimum Height *H* of Bend

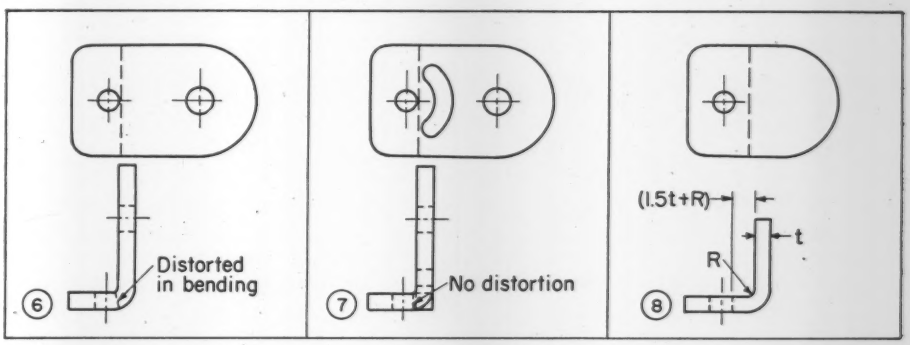
Stock Thickness	Bend Radius				
	Sharp	1/32	1/16	3/32	1/8
0.032	0.050 to 0.062	0.093	0.125	0.156	0.187
0.062	0.093 to 0.115	0.140	0.160	0.187	0.205
0.093	0.156	0.189	0.205	0.250	0.266
0.125	0.250	0.280	0.292	0.315	0.330
0.156	0.300	0.315	0.340	0.360	0.370

Should the overall height H be less than that shown in this table, considerable pull-down, such as indicated in *Fig.* 5, will be introduced until there is practically a sharp edge on the bent section. Should less height be necessary on the finished stamping than shown in the table, secondary machining operations, such as trimming, milling, etc., will have to be considered to give the part a square-edge finish.



Pierced Holes Close To Right-Angle Bends

OFTEN it becomes necessary to have a hole as close to a right-angle bend as possible, such as shown at *Fig.* 6. To get a normal hole at the right-angle bend, it must be pierced *after* the part is formed to shape. Otherwise, a distorted hole will occur as indicated in *Fig.* 6.



The same blanked and pierced part redesigned with the addition of a crescent slot is shown in *Fig.* 7. This design allows the part to be die-cut, blanked and pierced. There is enough flat material left around the desired pierced hole so that no distortion of material thickness affects the finished hole in the bending operation that follows.

While this design is not always permissible, it is quite often entertained from the standpoint of mass production, and it should be used with short pilot runs for developing part specifications in the event conventional type tooling is to be eventually employed. Stock left adjacent to the hole, of course, cannot exceed the material thickness of the stamping specification.

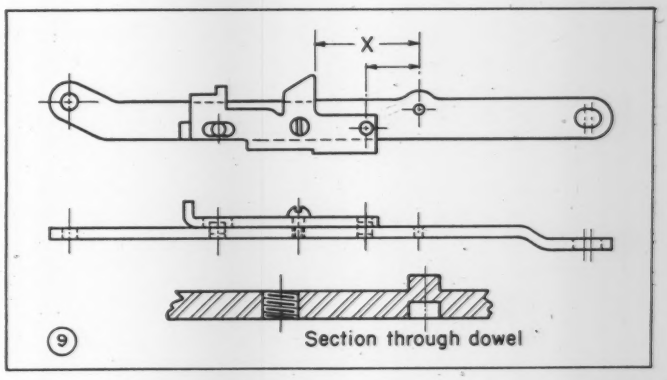
Fig. 8 shows the desirable location of a hole adjacent to a right angle bend. The edge of the hole should not be closer than one and one-half times the thickness of stock, plus the inside radius of the right angle bend.

Extruded Dowels For Mating Parts

DOWELING of two mating parts is usually introduced for holding a definite relationship from a given point on one part to a given point on the mating part. In this particular case, *Fig.* 9, it was most important that the dimension X be maintained, to assure accurate relationship between the two parts to as high a degree as possible at the lowest practicable cost.

Although the two dowels were extruded in the larger part, the location of the dowel shown enlarged and the hole in the mating part were the determining factors in holding dimension X. The second dowel was placed as far as possible from the first, and merely maintained the alignment.

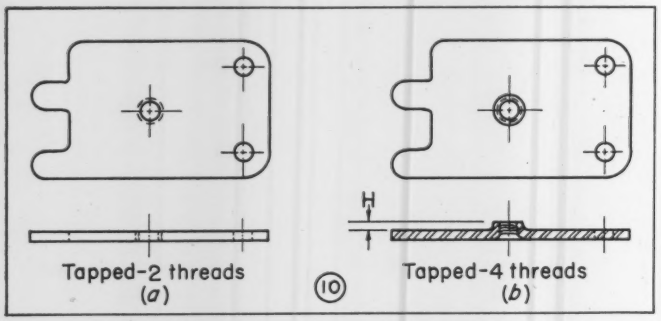
It should be remembered that there is bound to be some accumulated error in the diameter of the dowels, the diameter of the holes and the spacing of the dowels and holes. This was compensated for by piercing an elongated slot for the alignment dowel. All that is necessary is to maintain the correct diameter of both dowels, correct diameter of the mating hole,



and the correct width of the elongated hole. Such technique made it possible to assemble the small piece without selection and either spot weld or screw the mating parts together. The extruded dowels protrude through the mating part about one-half the thickness of stock.

Extruded Holes For Tapping

IN THE piercing and tapping of sheet metal stock, it is often advisable to use an extrusion at the point of tapping. Ordinarily, the maximum height H of the extrusion cannot exceed one-fifth of the body size of the tap. The material hardness should not exceed half-hard temper.



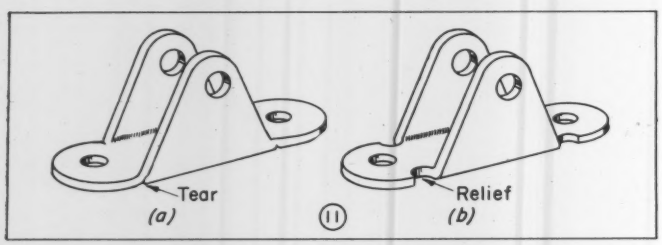
10

It can be seen by glancing at *Fig.* 10*a*, that only two threads could be produced, assuming this was an 8-32 thread. However, in *Fig.* 10*b*, 3½ to 4 threads would be possible, with an extrusion. Should conditions warrant, instead of using an 8-32 screw, a 10-32 thread should be employed, thus increasing the size of the hole and increasing the height H of the extruded section before tapping.

Since wall thickness in hole extrusion is approximately 75 per cent of the original stock thickness, it is advisable on lighter gages to use as fine a thread as possible to prevent break-through.

Right-Angle Bends

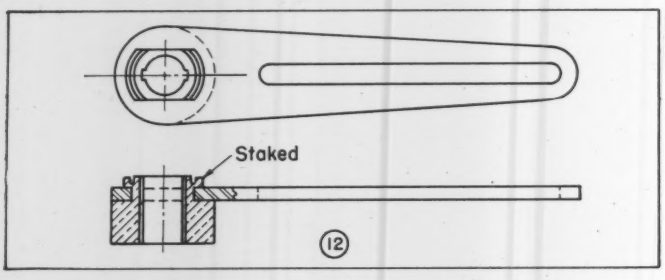
SIMPLE as it may be, the location of a right-angle bend to the major profile of a given blank may be most important. It is commonly understood that if the outside of the bend is parallel with the profile of the blank, regardless of the radius, a certain amount of fracturing or tearing of the material will be introduced, *Fig.* 11*a*. This amount of tearing will be increased or decreased, depending upon the radius on the outside of the finished formed part. This radius is increased or decreased depending upon the thickness of the material, together with other forming requirements.



11

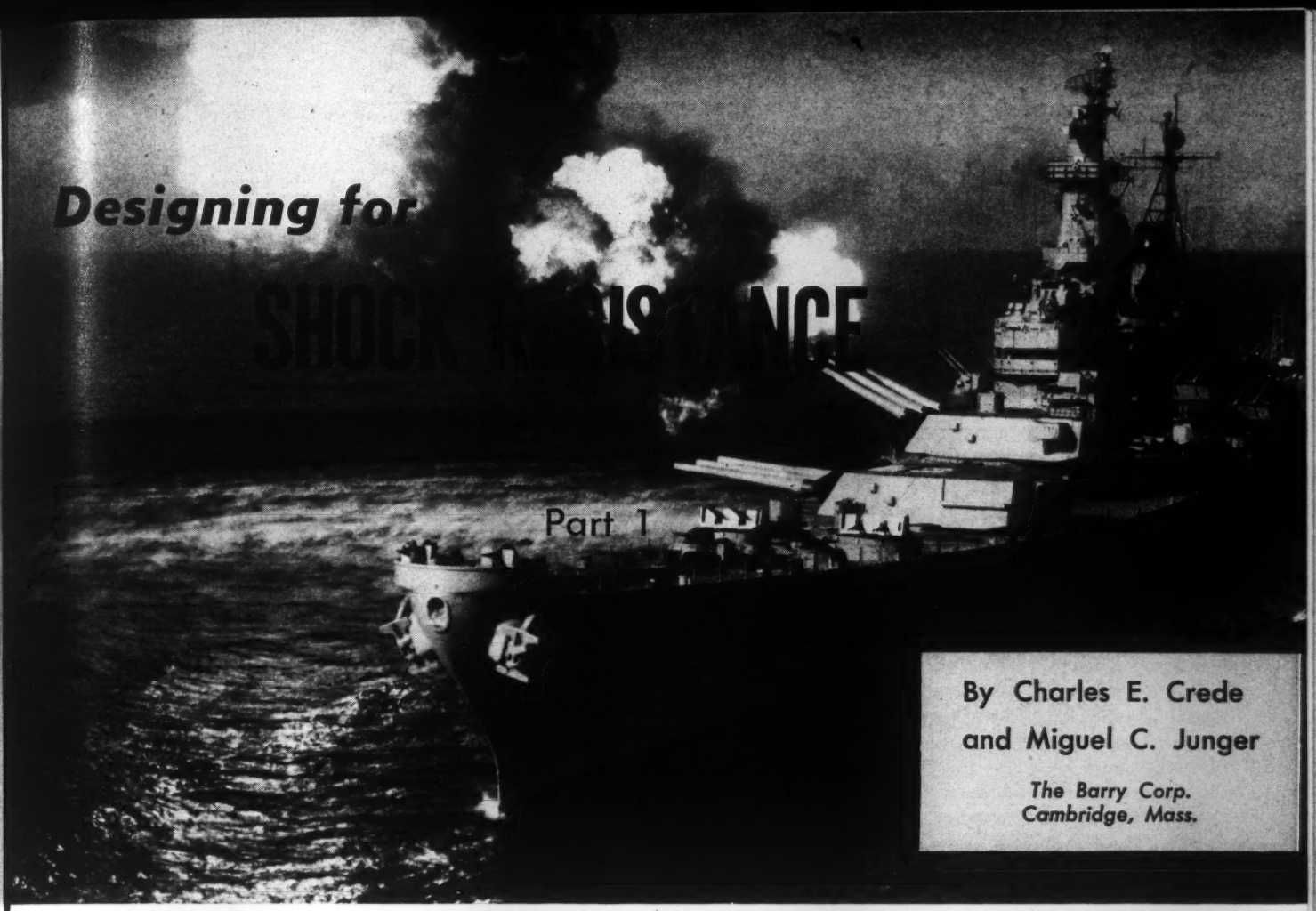
A common method to correct the fracturing or tearing tendency can be obtained by introducing notches for relief, such as shown at *Fig.* 11*b*. These relief notches can be produced in the profile of the flat blank, and should be twice the thickness of stock in width and twice the thickness of stock in depth, when design permits. The latter blank design gives a more satisfactory bend and greater rigidity in the bent section as applied to the major profile of the blank itself.

Round Pierced Holes With "Flats"



12

OFTEN it is necessary to stake together a screw machine part to a stamping such as that shown in *Fig.* 12. While one flat on the shouldered bushing is satisfactory, in some cases two flats on a shouldered bushing cost no more to produce, due to the fact they can be straddle-milled in one operation, permitting twice the holding power when such parts are staked together. The pierced hole in a blank with two flats also costs no more.



Designing for SHOCK RESISTANCE

Part 1

By Charles E. Crede and Miguel C. Junger

The Barry Corp. Cambridge, Mass.

Official U. S. Navy Photo

WHEN upon the advent of World War II, the urgent need arose to procure shock-resistant equipment in large quantity, the mechanics of shock damage was only imperfectly understood. Urgency of the requirements precluded thorough analysis of the problem and the most expedient method of meeting requirements was adopted. This consisted of empirically designing equipment to withstand the shock imposed by high-impact shock-testing machines. Cut-and-try methods were used extensively. Shock-resistant models of many types of equipment were developed in this manner, and a number of principles were evolved that contribute to good shock resistance. These principles are generally applicable, not only to military equipment, but to any equipment required to withstand shock. The principles that relate to shock resistance of structures are discussed in this and a subsequent article. Information for these articles has been provided by the Bureau of Ships, Department of Navy.

DECREASE OF USELESS WEIGHT: One of the primary principles in the design of shock-resistant equipment is to maintain the weight of components as small as possible, and the strength of structural members as great as possible. Under the influence of shock, the forces applied to the structural members consist largely of inertia forces, and the magnitudes of these forces are directly proportional to the masses from which the forces are derived. This principle becomes more important as the distance from the base

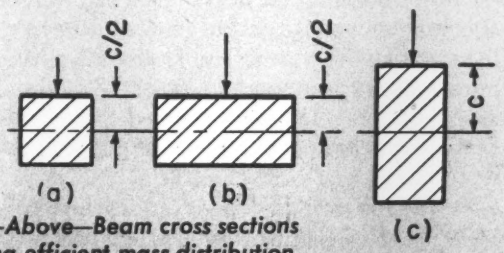


Fig. 1—Above—Beam cross sections showing efficient mass distribution

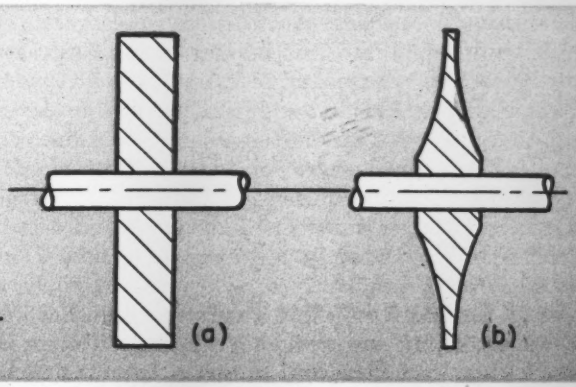


Fig. 2—Right—Turbine rotors illustrating optimum design (b) compared with higher stressed design (a)

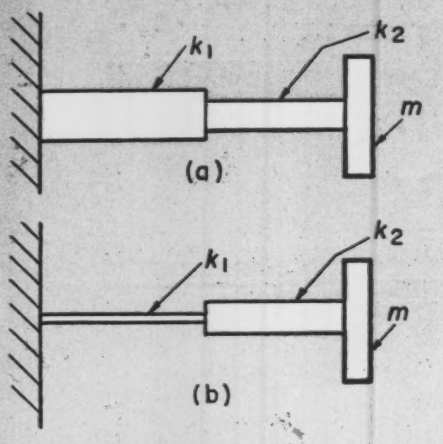


Fig. 3—Shock resistance of cantilever beam system improved by increasing flexibility of base member

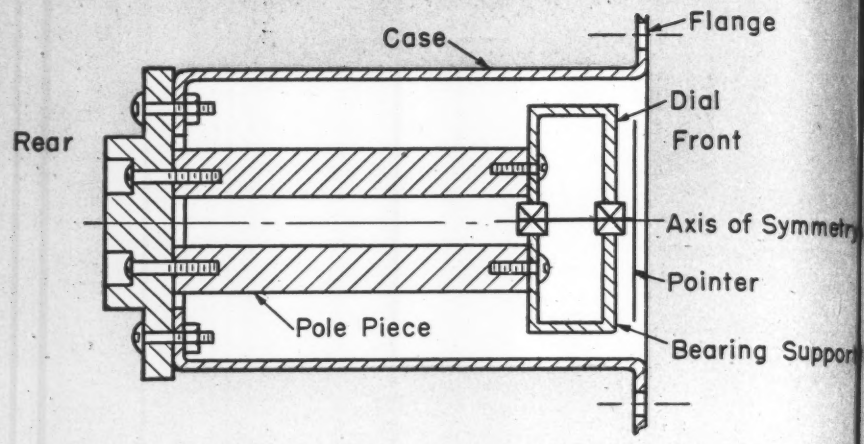


Fig. 4—Cross section of switchboard meter using flexible case for desired shock resistance

of the equipment increases. If the base is unnecessarily heavy, only the mounting bolts receive an excessive force; but, if a component remote from the base is unnecessarily heavy, all structural members between the component and the base must be strengthened to withstand the excessive force.

The most common example of the foregoing principle is encountered in the design of beams. The beam whose cross section is shown in *Fig.* 1*b* is twice as strong as the beam of *Fig.* 1*a* when loaded with an external force directed along the arrow. When loaded only by their inertia forces, however, the beams are of equal strength. The twofold increase in strength of the beam at *b* is exactly compensated by an equal increase in inertia force resulting from a twofold increase in its weight. On the other hand, doubling the depth of the beam, as shown in *Fig.* 1*c,* is efficient because it results in an eightfold increase of the cross-sectional moment of inertia, I, with a fourfold increase of the section modulus, I/c. The inertia force having been only doubled by the added mass, the maximum stress is reduced by 50 per cent.

Most Efficient Distribution of Mass

While some improvement can be attained by proper orientation of beams of rectangular cross section, an even more efficient distribution of mass is embodied in I-beams, channel beams, and other beams that dispose a substantial portion of the beam away from its neutral axis. Mounting feet, supports, levers, and similar members should be ribbed or otherwise stiffened in preference to the use of flat sections. The strength of flat panels under conditions of shock is increased by the provision of welded or formed stiffeners. This is a very effective method because a substantial increase in stiffness is attained with little addition of weight.

One of the most effective illustrations of the practice of obtaining an optimum design through decreased mass and increased strength is found in turbine rotors. This problem is closely related to problems of mechanical shock because the stresses in the rotor result partly from inertia forces. The problem is solved by a method which is applicable to the design of shock-resistant equipment. The volume of material adjacent to the base, or hub, is made large while that adjacent to the periphery is made small. The stress at the hub is thus maintained at a minimum, because a large area is available for supporting the load and because the load is maintained at a minimum by the reduction of mass at the periphery. The optimum design of rotor is shown in *Fig.* 2*b* which indicates, by comparison with *Fig.* 2*a*, the extent of the improvement which may be attained through the reduction of mass at the periphery.

The principle formulated earlier in this article states that the mass remote from the base be reduced as much as possible. A corollary to this principle, which applies when this mass must be great for functional reasons, is to provide a direct independent attachment for supporting the functional mass, thus transmitting the inertia forces directly to the foundation and by-passing other members of the assembly. The corollary may be illustrated by several common examples. A valve of the type used in steam, hydraulic, or compressed air systems should have a direct support independent of the pipes connected to the valve. The pipes are thus relieved from withstanding the inertia force of the valve. The common commercial practice of supporting small electronic components, such as resistors and condensers, by means of the electrical conductors should be avoided whenever practical in equipment required to withstand shock. The provision of independent supports for such components constitutes good design practice.

DECREASE OF STIFFNESS: A second important principle in the design of shock-resistant equipment is to introduce flexibility to some degree into base members, or into structural members which support vital or vulnerable elements of the equipment. This is illustrated schematically by the system shown in *Fig.*

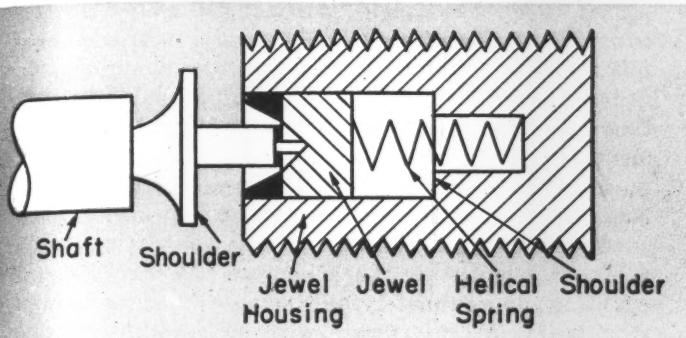


Fig. 5—Above—Section through flexibly-mounted instrument bearing

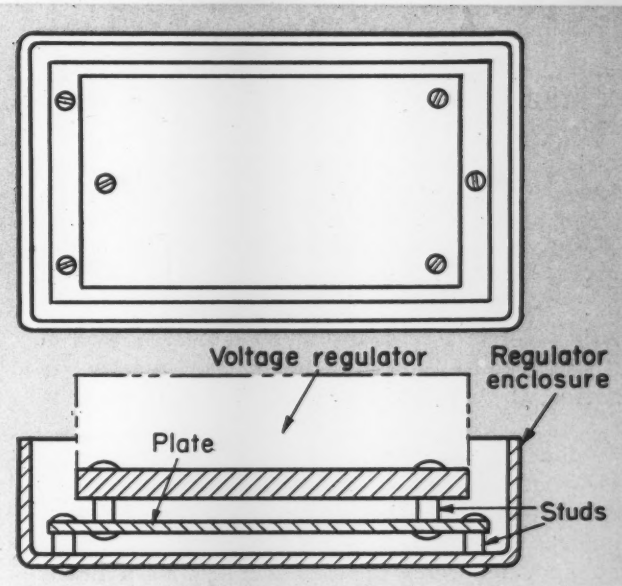


Fig. 6—Right—Flat plate employed to flexibly mount an instrument within an enclosure

3 which comprises two members k_1 and k_2 arranged in tandem to form a cantilever beam for supporting the mass m. In *Fig.* 3*a*, member k_1 is much stiffer than member k_2, and the natural frequency of the system is determined principally by k_2 and m. Since its natural frequency is known, the response of the system to an applied shock may be determined.

If the stiffness of member k_1 is reduced to k_1', as indicated in *Fig.* 3*b*, so that the stiffness k_2 becomes relatively much greater, the natural frequency of the system is determined principally by k_2 and m. It is then evident that the natural frequency of the system shown in *Fig.* 3*b* is lower than that of *Fig.* 3*a*. In general, the forces acting on mass m in *Fig.* 3*b* as a result of shock are substantially lower. In other words, the capacity of the system to withstand shock is increased. Many instances are on record in which shock resistance has been increased by the introduction of flexibility at a strategic location.

A switchboard meter of the moving coil type utilizes the case of the instrument to obtain the desired flexibility. This meter, as illustrated in *Fig.* 4, is of the flush-mounted type which extends rearward from the front of the switchboard, and is attached to the switchboard by means of a flange at the front end of the cylindrical case. The entire mechanism of the meter is supported from the rear end of the case. The flexibility of the front and rear portions of the case, in the direction of the axis of symmetry, provides a relatively low natural frequency in a direction normal to the switchboard panel. The case functions as a cantilever beam in all directions parallel with the panel of the switchboard, and exhibits flexibility, not only because of its own lack of stiffness, but also because of the flexibility of the switchboard panel to which it is secured. The mechanism is thus supported upon a relatively flexible support with respect to shock motions in any conceivable direction.

Another example of the application of this principle is the protection of ball bearings in electric motors by the provision of flexibility in the end bells. An analogy to *Fig.* 3 is evident, wherein the armature corresponds to the mass m, the shaft corresponds to the member k_2, and the end bells correspond to the member k_1. The maximum stress as a result of shock may then be reduced by decreasing the stiffness of the end bells. All members of the system benefit by this reduction, including the ball bearings which are subjected to a smaller force. The decrease in stiffness in the instance of the electric motor may be achieved through the use of pressed-metal end bells. With flexible end bells, there is less chance that the ball bearings will be damaged by shock than with rigid end bells.

Flexibility Increases Shock Resistance

A third example quite similar to the electric motor is found in a small meter whose shaft is supported at the end by a jewel radial and thrust bearing. When such a bearing is rigidly mounted, there is a tendency for the jewel to split and the end of the pointer shaft to become blunted as a result of the large inertia force imposed upon the jewel. By mounting the jewel upon a small helical spring, as illustrated in *Fig.* 5, the system becomes analogous to *Fig.* 3*b*. As a result of flexibility introduced by the helical spring, the maximum inertia force imposed upon the jewel is reduced. The shaft is provided with a shoulder which engages the jewel housing before the jewel bottoms upon the shoulder. Likelihood of damage to the jewel is thus decreased, and the accuracy of the instrument is preserved, by avoiding the blunting of the pointer shaft and eliminating the possibility of damage to the jewel.

The ability of a thin flat plate to flex a large amount without serious deformation has been used to introduce shock resistance in many types of equipment. The particular embodiment illustrated in *Fig.* 6 is employed to protect an instrument that is mounted within an enclosure. The plate is attached to the enclosure by means of three lower studs, while the instrument is attached to the plate by means of three

upper studs which are staggered with respect to the lower studs. The plate thus acts like a diaphragm in permitting movement of the instrument in a direction normal to the plate, and flexes readily to permit movement in a direction parallel to the plate.

OPTIMUM FLEXIBILITY: The examples cited to show the beneficial results attainable with a flexible support should not be interpreted to mean that shock resistance is always increased by the mere expedient of increasing the structural flexibility of the equipment. Whereas too little flexibility may result in excessive inertia forces, too much flexibility may result in damage to the flexible member or to associated members. Optimum flexibility lies between these extremes.

The degree of flexibility required depends upon the characteristics of the structure being considered. The need for flexibility may be shown by failure of the equipment to withstand shock, or may be indicated by an analysis which reveals the lack of a flexible support for a vulnerable, rigid member. In either case, an increase in flexibility is called for. The next step is to determine, from a study of the equipment, the member whose stiffness should be decreased. In general, optimum conditions embody the greatest acceptable stiffness. If the stiffness is too low, the natural frequencies are low and the following detrimental conditions may exist:

1. The deflections of structural members are great, and special attention should be directed to insuring that rupture or excessive deformation does not occur
2. One component may impact against another if supported upon structures which lack sufficient stiffness. In introducing structural flexibility, adequate clearances between components should be provided.

The benefits derived from the use of a flexible member may be decreased rather than enhanced if too many flexible members are used. An optimum design comprises a rigid, compact assembly attached to the supporting base by means of a relatively flexible member capable of withstanding an appreciable deflection. All elements of the supported assembly thus receive the same acceleration. If certain elements of the assembly have the same natural frequency as the flexible supporting member, a transient condition resembling resonance may occur. The shock excites free vibration of the supporting member. An element of the supported assembly, if resonant at approximately the same frequency, would then be excited to vibrate with an amplitude which increases at each cycle. A more rigid element, although subjected to this vibration, would not be excited into resonance. It follows, therefore, that the benefits attainable by the use of a flexible member are not fully realized unless all elements of the assembly supported by such members are made substantially more rigid than this flexible member.

Another limitation on the degree of flexibility which can be tolerated is dictated by the requirement that the parts of the equipment not be resonant with any steady vibration to which the equipment is subjected. It should be remembered that this steady vibration is continuous and could result in fatigue failure of the lightly damped members of the equipment if a resonant condition should result.

MAXIMUM ENERGY STORAGE: The preceding explains the advantages which result from flexibility of structural members, and points out certain limitations on the degree of flexibility. Flexibility infers a relatively low natural frequency. A member of low natural frequency experiences a large deflection, and must be structurally capable of withstanding such a deflection. The deflection of an elastic member is an indication that it has stored energy. Structural members should therefore be designed to store as much energy as possible before the metal in the most severely stressed region reaches the elastic limit. This requires, in effect, that the stress be maintained as uniform as possible throughout the

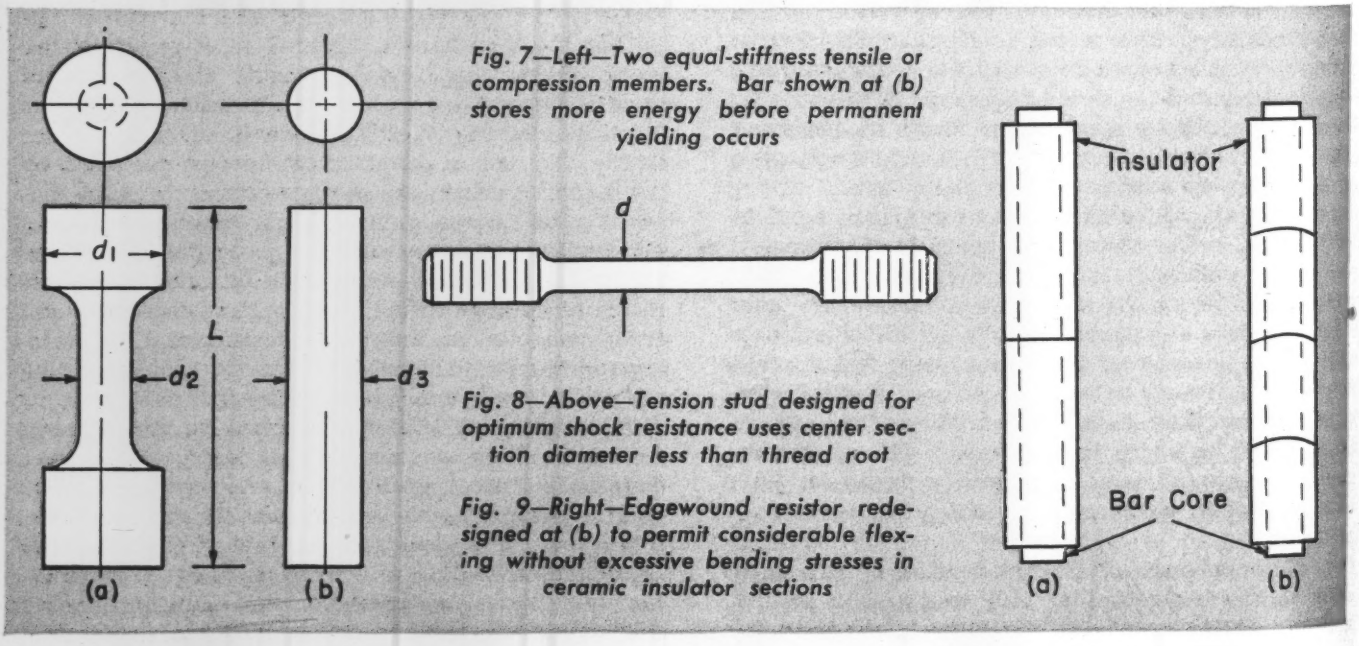


Fig. 7—Left—Two equal-stiffness tensile or compression members. Bar shown at (b) stores more energy before permanent yielding occurs

Fig. 8—Above—Tension stud designed for optimum shock resistance uses center section diameter less than thread root

Fig. 9—Right—Edgewound resistor redesigned at (b) to permit considerable flexing without excessive bending stresses in ceramic insulator sections

member. The basic principle of design may now be stated: All structural members should be designed, insofar as possible, to experience the same stress throughout in order to insure the greatest possible energy storage before yielding occurs in any part of the structure.

The principle of maximum energy storage may be illustrated by considering two members, as shown in *Fig.* 7, subjected to pure tensile or compressive stress. The two members are made of the same material, and have equal length and stiffness. The diameters therefore must be in accordance with the relation, $d_1 > d_3 > d_2$. Since the stiffnesses of the two members are equal, their maximum total deflections when subjected to shock are equal. It now becomes of interest to examine the unit strain and unit stress. In the member shown in *Fig.* 7*a*, the strain is limited largely to the small portion whose diameter is d_2. In the member shown at *b*, however, the strain is distributed equally over the length. The unit strain, and therefore the stress, is lower in member *b* than in member *a* for the same over-all deflection. A greater over-all elastic deformation thus becomes possible when the section is substantially uniform from end to end, and a greater amount of energy may be stored before permanent yielding occurs.

Uniform Section Permits Greater Deformation

This principle is applied to good effect in the design of long bolts and studs loaded in tension by shock forces. A stud is shown in *Fig.* 8, in which the diameter, *d*, of the central portion is made slightly less than the diameter at the root of the thread. The reason for this is that stress concentration develops at a notch, such as a thread, and the actual maximum stress is somewhat greater than would be inferred from the root diameter. This should be taken into account in arriving at a diameter *d*. If this diameter is properly selected, the actual stress in the central portion will be slightly greater than the stress at the root of the thread. The member then embodies optimum design from the standpoint of shock resistance.

An ideal design of member intended to be subjected to a bending moment would have a uniform stress throughout the entire area of the cross section. It has been pointed out that I-beams and channels are preferred to solid beams because they approach more closely to this ideal. That reasoning was applied to the design of a beam intended to support its own weight under conditions of shock. A similar conclusion is reached in designing a cross section to insure maximum energy storage. The most efficient arrangement would have all material at an equal distance from the neutral axis. This is not practicable, however, because it provides no constraints for this material. It can be approached, for example, in the commercial channel loaded parallel with the web.

Equipment frequently can be protected from shock by designing the mounting bolts with low strength and low stiffness. This often represents the only means by which flexibility can be attained, as in equipment having a heavy cast base. The possibility

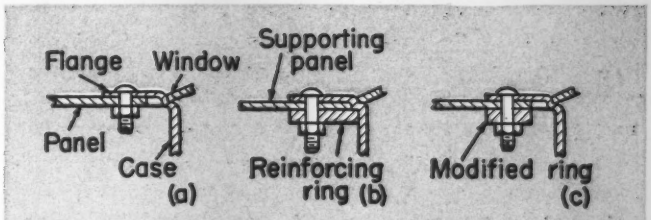
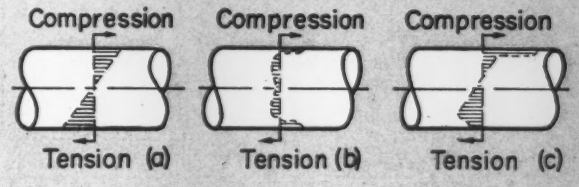


Fig. 10—Above—Support for glass instrument window redesigned unsuccessfully with rigid reinforcing ring as at (b) and successfully with modified ring (c)

Fig. 11—Below—Effect of residual compressive stress upon member subjected to bending



should always be explored, however, of employing base members whose stiffness is equal to or less than that of the mounting bolts. A member of substantial size, such as a mounting bracket or a structural member of a large switchboard, presents much greater potential energy storage capacity than a bolt.

AVOIDANCE OF STRESS CONCENTRATION: The next important design principle is that stress concentration should be avoided to the greatest extent possible. This could perhaps be considered a special case of the preceding principle, but is treated separately here because it deals with localized conditions whereas the preceding principle treats structural members from an over-all viewpoint. If local yielding or rupture takes place, the structure as a whole is prevented from capitalizing its potentialities as an energy-storing medium. This was considered in detail in connection with the preceding principle.

AVOIDANCE OF PARALLEL CONNECTION OF FLEXIBLE AND RIGID MEMBERS: The next basic principle applies to the design of composite structures comprising both flexible and rigid members. Rigid elements should not be arranged in parallel with flexible elements, unless the rigid elements have adequate strength to constrain the flexible elements against the forces generated by shock motions. Flexible elements often serve a valuable function of reducing the acceleration experienced by components of the equipment, and this function should not be unnecessarily impeded by the application of rigid constraints. Several examples will illustrate various aspects of this condition.

The first example refers to the edgewound resistor shown in *Fig.* 9, wherein the brittle element is the rectangular ceramic insulator and the flexible element is the steel bar core embedded in the ceramic sections. The original design embodied long, square-ended ceramic sections as shown in *Fig.* 9*a*. These sections would chip off near the ends and split lengthwise as a result of flexure of the relatively flexible steel core. The new design embodies shorter ceramic

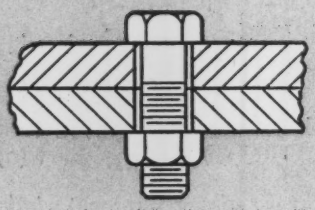


Fig. 12—Above—Unsatisfactory method of fastening two members with bolts in clearance holes

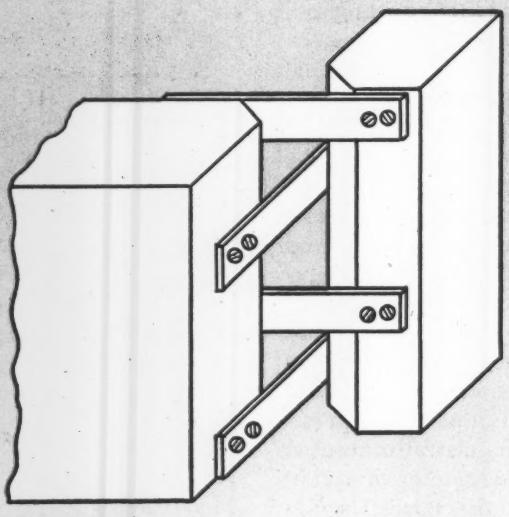


Fig. 13—Right — Elastic hinge substitute for knife edge, eliminating possibility of shock impact between knife edge and seat

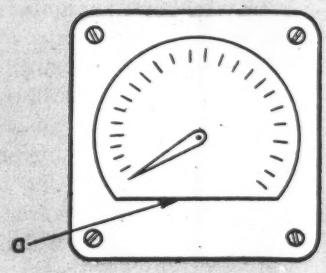


Fig. 14—Above — Flat section on front of meter case for preventing ejection of mechanism from case if holding screws fail

sections with rounded ends as shown in *Fig.* 9*b*. The knee action thus provided permits the resistor to undergo considerable flexing without imposing substantial bending stresses on the ceramic sections. The likelihood of shock failure is thus materially reduced. In this instance, shock resistance was obtained by making the rigid element capable of partaking of the deflection of the flexible element. In general, shock resistance tends to be increased by a change which brings the stiffnesses of the two elements more nearly into equivalence.

Series Arrangement Eliminates Relative Motion

It often is advisable to avoid all parallel connections by cascading the elements or, in other words, by employing only series connections. This is illustrated in the cross section of the meter, *Fig.* 4. This meter is mounted substantially in the plane of its face by means of a peripheral flange extending outwardly from the cylindrical case. The pole piece is attached to the rear end of the case. The front end of the pole piece carries the bearing support to which the dial, in turn, is attached. All vital elements are thus cascaded. It is readily visualized that, if the dial were attached to the case, relative motion would result between the dial and the pointer when the pole piece deflects relative to the front of the case. Possibility of damage resulting from this relative motion is eliminated by cascading the elements, thereby eliminating the relative motion.

An interesting instance of the failure of a rigid member as a result of deformation of a flexible member is found in a small instrument having a glass window. The arrangement, as shown in *Fig.* 10*a*, embodies a glass window soldered to the cylindrical case of the instrument adjacent to the peripheral mounting flange. The instrument is mounted by securing the flange to a supporting panel. During shock, the mounting flange experienced substantial deformation and the glass, being unable to withstand such deformation, failed. A reinforcing ring as shown in *Fig.* 10*b* was then added to reduce the deformation experienced by the mounting flange. The result was continued failure of the glass, not because of deformation of the flange, but now because of the large force transmitted by the rigid reinforcing ring. A modified reinforcing ring as shown in *Fig.* 10*c* serves to prevent excessive deformation of the flange while leaving adequate flexibility between the glass and supporting panel to prevent transmission of the destructive large force.

Residual Compressive Stress: Another basic principle, applicable particularly to members subjected to a bending moment, is to maintain the outer fibers of the member under a residual compressive stress. Cracks leading to failure of a member subjected to bending usually start at the surface which has a tensile stress. The crack does not start if the surface stress is compressive. A residual compressive stress serves to reduce the resultant value of any superimposed tensile stress.

The stress pattern in a member subjected to bending is shown in *Fig.* 11*a*. If the member, prior to being stressed, is subjected to cold rolling, shot peening, or nitriding, the surface fibers of the member receive a compressive stress. In order to attain an equilibrium condition, the core of the region has a tensile stress, as shown by the residual stress pattern in *Fig.* 11*b*. When the member having the residual stress of *Fig.* 11*b* experiences the bending stress of *Fig.* 11*a*, the two stresses are added to produce the resultant stress shown in *Fig.* 11*c*. It is thus evident that the maximum tensile stress in bending is reduced and the maximum compressive stress is increased. Since a crack starts in a region of tensile stress, the strength may be considered to be increased.

The same principle is employed in a somewhat different manner to increase the strength of brittle materials, which are characteristically weak in tension and strong in compression. Porcelain, for example, is an invaluable ceramic for use in electric resistors because of its electric properties. The material, however, has a very low tensile strength. This disadvantage is largely overcome by inserting a steel

bolt through the central hole of the porcelain bushing. The bolt is tightened and the porcelain is stressed in compression. Any subsequent loading which tends to apply a bending moment must overcome the residual compressive stress in the porcelain before the tensile stress becomes of appreciable magnitude. The strength of the bushing is thus increased.

LIMITATIONS OF FRICTION AND GRAVITY FORCES: It may be stated as a general rule that gravity and friction forces should not be relied upon to position members whose positive positioning is essential to the operation of the equipment. The inertia forces developed during shock frequently are greater than the designer envisions, and friction forces which would be adquate under static conditions may not be satisfactory under shock. The nature of the trouble which develops, and the remedies therefor, will become apparent from the following examples.

Positioning By Gravity Is Inadequate

The forces of gravity should never be relied upon to maintain an equipment or component positioned on a ship, vehicle or aircraft. Members resting in receptables, such as batteries in battery racks and tools on tool racks, should always be held in position by clamps or other suitable means. A body suspended on open-end helical springs is not satisfactorily secured because it may experience motion of such large amplitude that the springs are relieved of tension and become disconnected. Such springs should be so attached that they cannot be accidentally disconnected.

Two members, attached by bolts in clearance holes as shown in *Fig.* 12, and positioned relative to each other only by the friction at the interface, may be moved out of alignment by the shock. This can occur as a result of permanent elongation of the bolt and release of the friction forces at the interface. High speed motion pictures show instances where the bolt elongates elastically and the bolted members shift position during the momentary release of the friction. Bolted joints are also known to have become loose as a result of the nut backing off while the bolt is momentarily elongated elastically.

Elongated bolt holes are thus undesirable because they permit excessive misalignment. The same objection applies to open slots, which are more objectionable because of the possibility of disengagement. Acceptable designs employ dowel pins or keys in addition to bolts, or utilize body bound bolts; i.e., bolts which fit snugly through the holes and thereby prevent misalignment. Members which require adjustment during or after final assembly may be provided with dowel pins inserted in holes drilled through the two members after the final position has been accurately determined.

It is preferable not to secure machine elements, such as gears and cranks, to shafts by means of friction forces alone. Press or shrink fits, which are commonly used commercially, are frequently unsuitable for shock-resistant applications because the friction created thereby may not be adequate to locate the element securely. Such elements should be pinned or keyed to the shaft wherever possible in order to maintain positive alignment. There is also need to prevent misalignment parallel with the shaft.

Clearances and backlash should be eliminated wherever possible from mechanisms used in shock-resistant equipment. In this respect, knife-edge supports are particularly objectionable because it is difficult to positively maintain the knife edge in contact with the seat without applying a large restraining force which unduly sacrifices the accuracy of the support. Impacts between the knife edge and its seat are thus likely to occur with consequent danger of damage thereto. Further difficulty arises from the tendency of the knife to slide lengthwise on the seat. An effective replacement for a knife edge is a journal bearing, where some friction can be tolerated, or an elastic hinge as illustrated in *Fig.* 13, where friction is intolerable but an elastic moment acceptable.

LIMITING MEANS FOR FLEXIBLE MEMBERS: A member required to remain permanently undeformed may be provided with means to limit its deflection so that the stress does not exceed the yield stress. It may sometimes be impossible, for reasons peculiar to the equipment, to attain the necessary strength inherent in the member. Where a particularly vital member is involved, it is good foresight to provide limiting means as insurance against the very occasional shock of extreme severity which would otherwise cause damage to such a member.

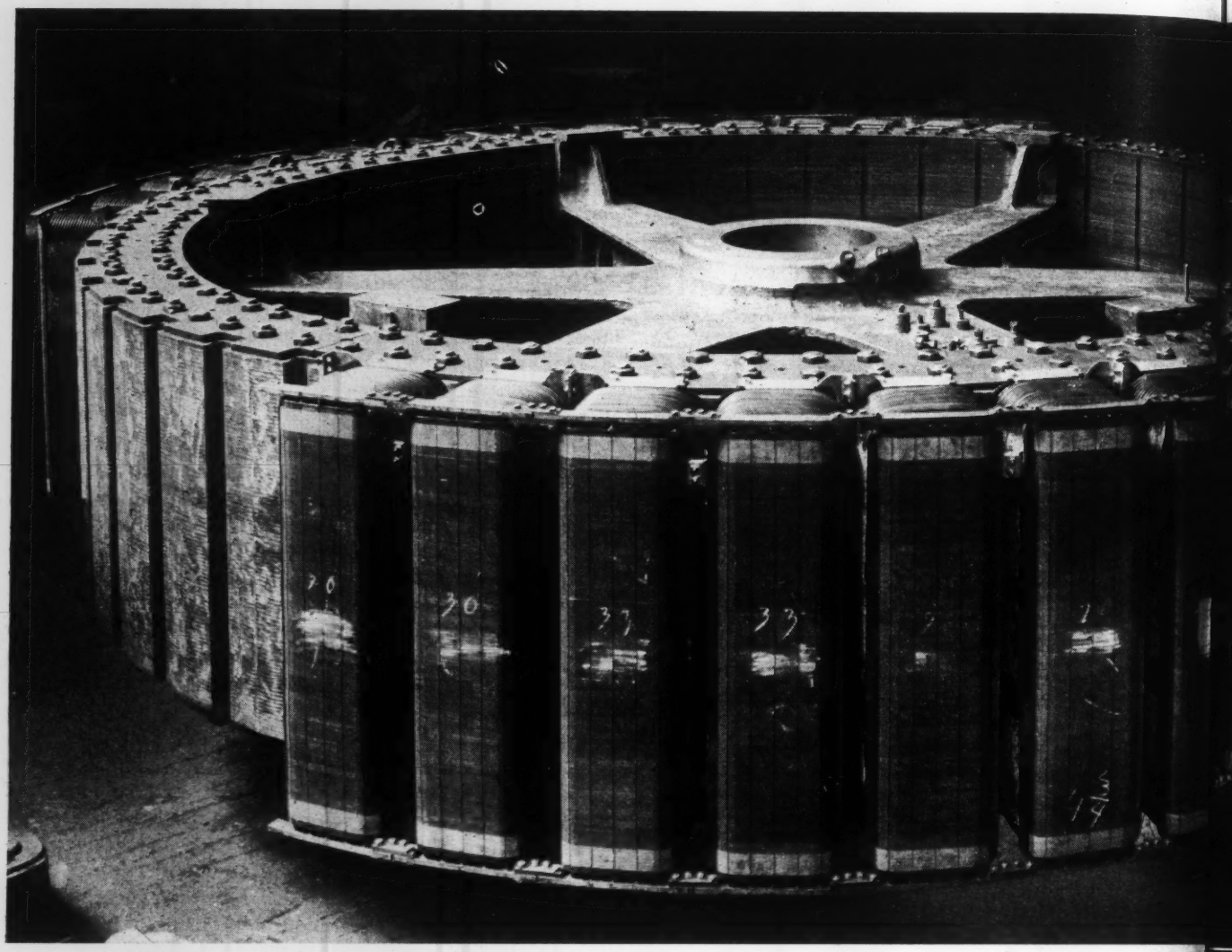
CAPTIVE RETAINING MEANS: In the design of equipment for shock resistance, care should be exercised to prevent secondary damage resulting from a primary failure. The primary failure, in the instance referred to, usually takes the form of rupture of a securing means. An auxiliary retaining means should be provided to maintain the equipment or component captive, and prevent its becoming a projectile. Such a projectile is hazardous for several reasons:

1. It may cause mechanical destruction of adjacent equipment in its path
2. It may fall across live electrical conductors or moving parts, causing damage to or immobilization of other equipment
3. It may cause injury to personnel.

Referring to the meter shown in *Fig.* 4, if the screws which secure the pole piece to the rear of the case should fail under shock, the entire inner mechanism may be projected through the instrument window unless retaining means is provided. In order to prevent this eventuality, the shape of the window is made substantially round but with a lower flat portion, *a*, as shown in *Fig.* 14. The flat portion of the metal cover forms a barrier to prevent ejection of the mechanism from the case, with possible danger to personnel working in front of the switchboard.

Shock mounts should be designed so that the equipment remains captive, even though the resilient element ruptures. It is satisfactory to use, in conjunction with rubber shock mounts or as a part thereof, an assembly of interlocking metal members which positively retain the mounted equipment captive.

The final section of this two-part series, to appear in a subsequent issue, outlines basic principles of design to prevent maloperation of equipment subjected to shock.



Designing a Large Weldment

By L. G. Hauser
Westinghouse Electric Corp.
Buffalo, N. Y.

A WATERWHEEL generator is the heart of large, present-day hydroelectric power stations. An up-to-date version of the old fashioned waterwheel used years ago, modern generators have generally been designed with all structural parts of welded construction except the rotor spider, *Fig.* 1. This part has been of cast-steel as shown in *Fig.* 2, until recently it was decided to investigate the possibilities of welded design for this critical component.

Rim of the generator rotor is made of laminated electrical steel. Stacked around the spider to the proper height, these laminations are heated to a predetermined temperature by electric space heaters. This, of course, causes the rim to expand and at this temperature the laminations are bolted solidly together by the double row of bolts seen in *Fig.* 1. On cooling the rim contracts around the spider and creates a compression loading.

There is nothing new in shrinking a rim onto a wheel except in this case the heating and shrinking are controlled to give a stress of about three million pounds per leg. When the rotor is at operating speed, centrifugal force is about three million pounds per leg and thus the rim is literally floating on the spider because the compression force caused by the shrinking is counteracted by the centrifugal force of speed.

Based on a paper presented at the Eleventh Annual Ohio State Welding Engineering Conference in Columbus, Ohio, April 14-15, 1950.

Cast-steel spiders are usually made from 0.35-carbon steel. From a design standpoint this cast steel has a yield point of 35,000 psi. Since physical dimensions of a fabricated spider would be essentially the same as for the cast-steel spider, *Fig.* 2, rolled 2-inch SAE 1015 plate was employed for the legs. This plate has a yield point of 30,000 psi.

Theoretically, the fabricated spider would weigh more than the cast-steel design, but this is not the case in actual practice because it is necessary to make the cast flanges thicker than the design calls for to eliminate warpage in the spider legs when the casting is cooling. Actually, the weight of the fabricated steel spider is approximately the same as that of the cast-steel job.

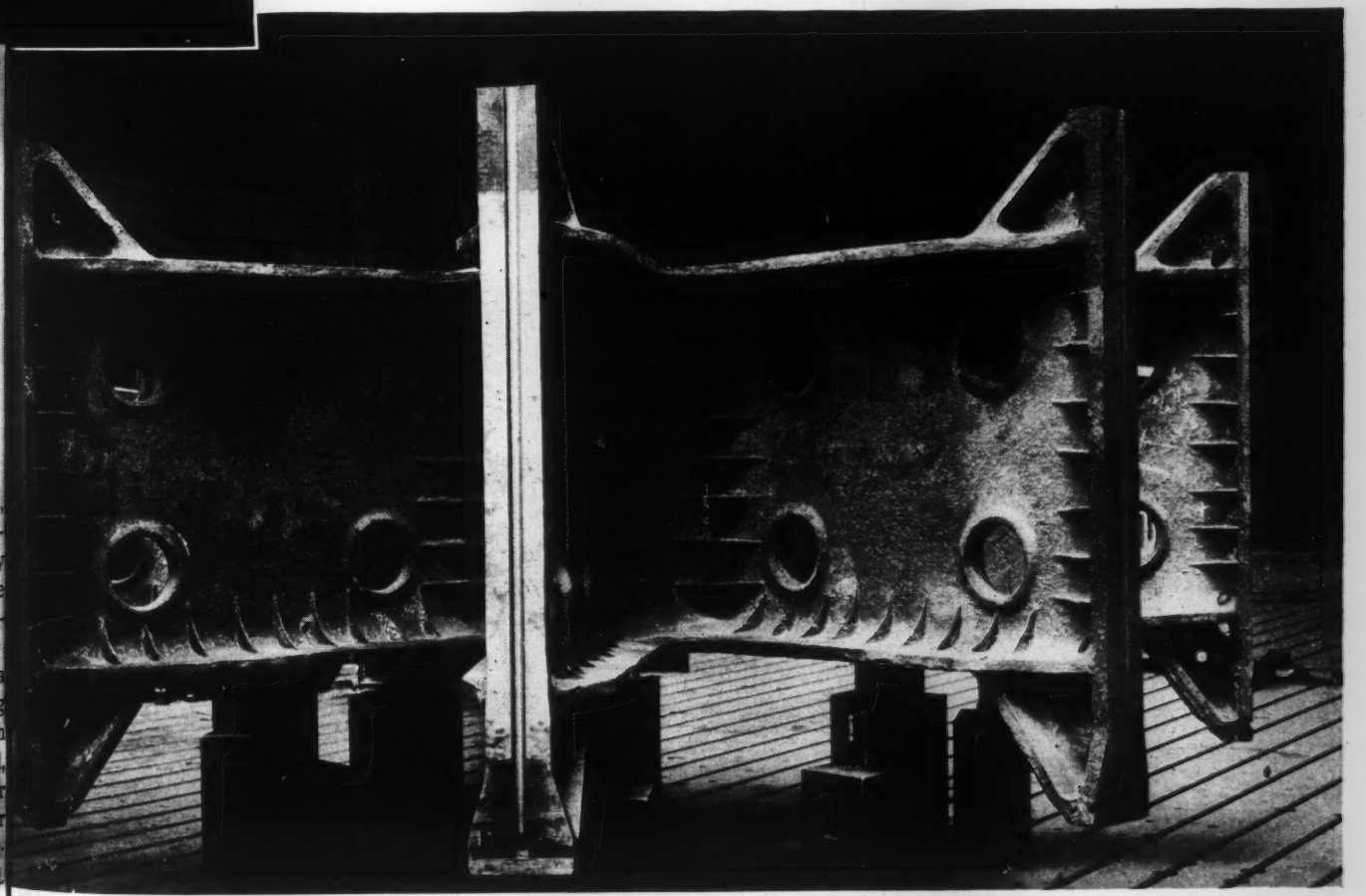
It is not feasible to fabricate the heavy steel hub from rolled plate. A cheaper and better method is to make the hub from an SAE 1035 steel forging. As can be seen from *Fig.* 3, the side or flange plates are cut from one piece of plate. This gives two sprocket-shape pieces which must be fastened to the hub. This joint is the most critical in the whole spider. Rather than make a tee-joint at the hub, use of a 2-inch nose projecting from the hub permits fastening the flange plates with a double-U butt joint. This double-U butt joint enables a better quality weld to be made at this point.

WELDING: The hub and the flange plates are pre-heated to 300 F and kept at this temperature during the whole welding operation. Three-sixteenth inch diameter 6011 electrode was used with a-c welding current. After both flange plates had been completely welded to the hub the spider was placed in an annealing furnace and brought up to 1150 F. It was cooled at the rate of 100 F per hour until 300 F was reached. At this point the welds were x-rayed for quality.

The next step was to weld the six web plates in place. The first welds to be made were the fillet welds attaching the web plates to the hub. These welds were made in the vertical up position using 6011 electrode. The fillet welds attaching the web plates to the flange plates were made in the horizontal fillet position using 6020 electrode,

Fig. 1—Left — Waterwheel generator rotor partially constructed using a cast-steel center spider. Redesign for welding reduced cost

Fig. 2—Below—Cast-steel center spider used for generator rotor. Outer flanges are increased in thickness to resist warpage



with one on each side of the web at each flange. After this operation was completed on all six legs the spider was again placed in the annealing furnace. The same annealing procedure was used. After annealing, the web welds were Magnafluxed for defects.

The plate assemblies which appear on the end of each leg were made as subassemblies. The subassemblies were welded to the spider legs out of position using 6011 electrodes. The entire spider was again annealed and all welds in the spider were Magnafluxed for defects.

COST ANALYSIS: There is a decided savings realized by the change from cast to fabricated steel. This is indicated, for example, by representative costs of equivalent spiders. The rough casting as delivered from the foundry costs $17,406. Grinding and Magnafluxing the casting cost $4046, including welding of defects. A cast-steel spider thus costs $21,452 in the unfinished condition. Machining costs which include removing of excess stock, turning, boring and facing the complete spider amount to $6070. This brings the total cost of a finished cast-steel spider into the neghborhood of $27,500.

Finish Machining Costs Lower

The forged hub used in the fabricated steel spider costs $5514, steel plate $3800, making a material cost of $9314. Machining and burning preparatory to welding costs $1943. The welding, annealing, assembly and inspection of the complete spider costs $8850, making the fabricated steel spider approximately $20,107 in the unfinished condition. Finish machining which includes turning, boring and facing costs $5121, resulting in a total cost of a finished fabricated steel spider approximately $25,200.

It will be seen that there is a large saving in the finish machining cost of the fabricated steel spider. This is due to a well planned and closely supervised welding procedure which keeps warpage to a minimum. As a result, the rough dimensions could be kept closer to the finish dimensions to reduce the amount of excess stock necessary.

Greater Design Leeway

SUMMARY: In order for a fabricated part to replace a cast part, the welded part must equal or better the cast part in several categories:

1. *Quality*: In this case the quality of the fabricated steel spider is equal to or better than the quality of the cast steel spider
2. *Cost*: The finished fabricated steel spider represents a saving of approximately ten per cent of the cost of the cast steel spider
3. *Weight*: The finished weight of the two spiders is approximately the same
4. *Cost of Design Changes*: Cost of design change for the fabricated spider would be limited to the engineering and drawing costs. In the case of the cast-steel spider there would be the additional cost of a pattern change
5. *Production Control*: The fabricated steel spider can be manufactured from raw material to finished product in our own shops. This gives complete control of production and quality.

Since our shops cannot handle castings of such size it is necessary to purchase them. Fabrication thus eliminates dependence on outside sources for quality and deliveries as well as a substantial portion of the original cost.

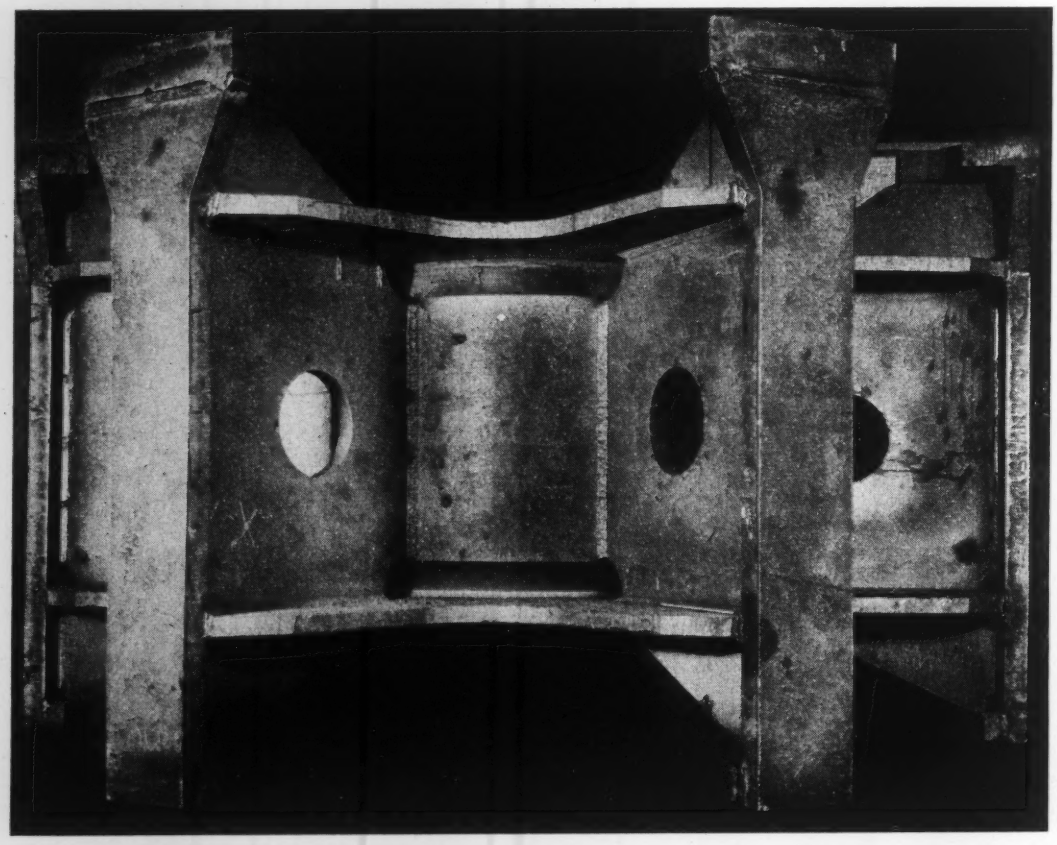


Fig. 3—Left—All welded SAE 1015 steel rotor spider to replace that of Fig. 2

Stepped Film Bearings

By Frank R. Archibald
School of Engineering
Princeton University
Princeton, N. J.

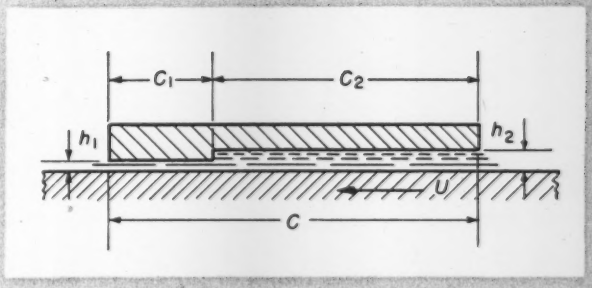


Fig. 1—Parallel-film step bearing discussed in article, showing stationary stepped plate at top, moving bearing surface at bottom

SUCCESS of the inclined, flat plate slipper bearing has resulted in a virtual neglect of other bearing design possibilities. In a little known paper by Lord Rayleigh[1], dated 1918, the problem of the slider bearing with no side leakage is examined in great detail. Rayleigh showed that the film shape for greatest load capacity is a stepped parallel form as shown in *Fig.* 1.

The author has considered the stepped film shape when side leakage is taken into account and found it to compare very favorably with the common inclined plane bearing.[2] When side leakage is neglected, the maximum load per unit width supported by the stepped slider, W_{max}, is

$$W_{max} = \frac{0.206\,\mu U c^2}{h_1^2}$$

where μ is the lubricant viscosity, U is the sliding velocity and c and h_1 are dimensions shown in *Fig.* 1. The proportions in this case are $c_2 = 2.549c_1$ and $h_2 = 1.866h_1$. An inclined flat plate having the same constraints will support a maximum load of

$$W_{max} = \frac{0.160\,\mu U c^2}{h_1^2}$$

The stepped arrangement under this condition is about 29 per cent more effective. This advantage is not held when side leakage is considered. For a square bearing the stepped shape is only about 3 per cent more effective than the inclined flat plate.

When side leakage is considered, the foregoing formulas require considerable modification. They can be written

$$W = \frac{K_1\,\mu U b c^2}{h_1^2}$$

where b is the width and K_1 is a coefficient which de-

[1] References listed at end of article.

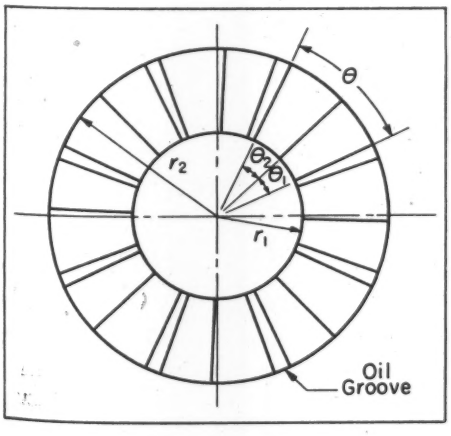


Fig. 2—Left — Arrangement of sector pads for thrust bearing using stepped construction

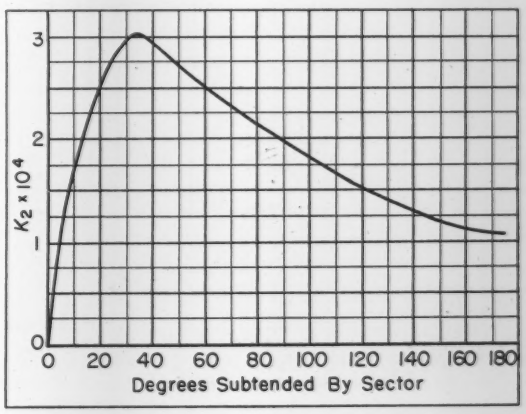


Fig. 3 — Right — Curve for determining K_2 coefficient for use in load formula

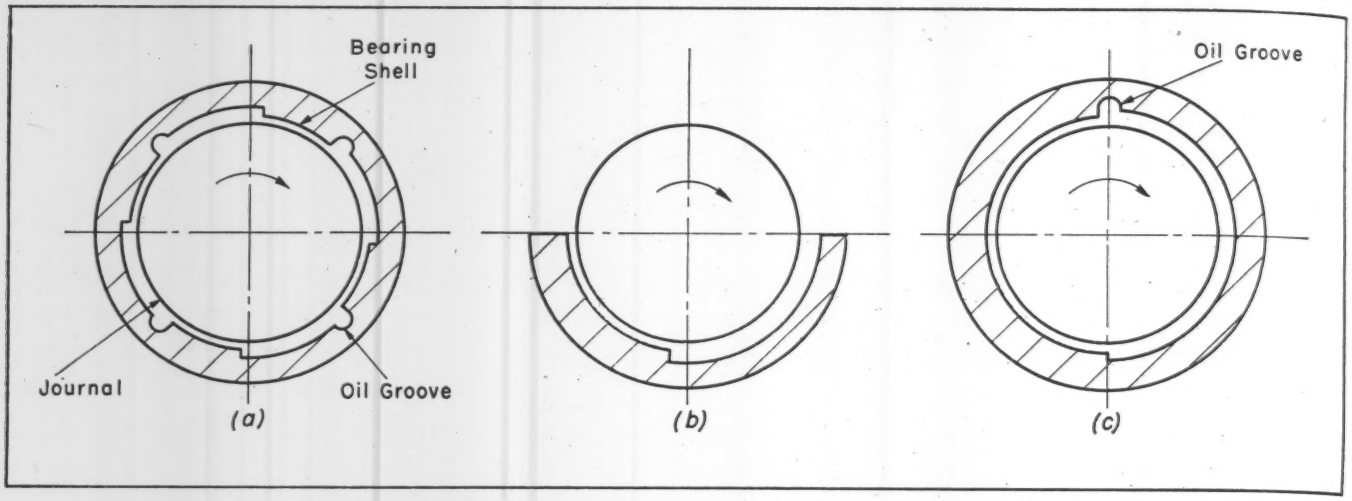


Fig. 4—Application of parallel step design to journal bearings. Arrangements shown at (b) and (c) are suitable for loading in one direction only

pends on the width-length ratio. Values of K_1 for the stepped bearing for various width-length ratios are given in TABLE 1.

The best proportions for a bearing of finite width are somewhat different from those where side leakage is neglected. For a square bearing the best proportions are $c_2 = 1.2\ c_1$, $h_2 = 1.7\ h_1$. But the load capacity is not greatly affected by changes in these values over a wide range. The values for TABLE 1 are all computed using $c_2 = 1.2\ c_1$ and $h_2 = 1.7\ h_1$.

The usual arrangement for a flat bearing is in the form of a sector pad for a thrust bearing as shown in *Fig.* 2. In this case the load formula is

$$W = \frac{K_2\ \mu N r_1^4}{h_1^2}$$

where N is the speed in revolutions per minute, θ is the total sector angle in degrees and r_1 is the inside radius of the bearing sectors. Values of the coefficient K_2 are given in the curve of *Fig.* 3, with values based on a ratio $r_2/r_1 = 2$. The proportions of the steps are $\theta_2 = 1.2\ \theta_1$ and $h_2 = 1.7\ h_1$.

Journal Bearing Applications

By use of *Fig.* 3 it is possible to find the number of pads for the greatest load if an oil groove size is selected. For example, if 5 degrees is taken for the oil groove, it turns out that 8 pads give greatest load capacity. Where the thrust capacity desired is small, the bearing can be made more simply by using fewer pads.

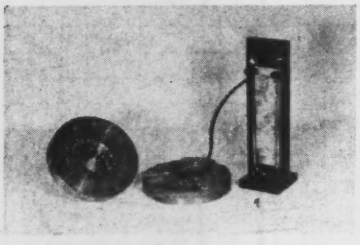


Fig. 5—Air-lubricated model of parallel step bearing uses 0.00005-inch step height, develops 3 inches mercury pressure at center of bearing pads

The possibility of applying the stepped film to journal bearings is interesting. *Fig.* 4 shows three possible arrangements. *Fig.* 4*a* is perhaps the most interesting. It would be a stable arrangement and has possibilities for a grinding machine spindle bearing, for instance. *Figs.* 4*b* and *c* are only suitable for loading in one direction. The author has considered the side leakage problem for these bearings but the analysis is long and has not been reduced to a readily workable form.

TABLE 1—Width-Length Ratio Coefficients

$\frac{b}{c}$	K_1	$\frac{b}{c}$	K_1
¼	0.0001842	1	0.07251
½	0.01350	1½	0.1566
¾	0.03998	2	0.2480

This stepped film arrangement, either as a thrust or journal bearing, should find many industrial applications. For a thrust surface, the shape is easily produced since it can be made on a surface grinder. Considerable self-alignment could be provided if the thrust element were set in an oil-resisting rubber. An air-lubricated model of a parallel step thrust bearing has been built for demonstration purposes, as shown in *Fig.* 5. The step height (i.e., $h_2 - h_1$) is about 0.00005-inch. When running, pressure about 3 inches of mercury is obtained at the center of one of the pads.

[1] "Notes on the Theory of Lubrication", *Philosophical Magazine*, Vol. 35, 1918, Pages 1-12.

[2] "A Simple Hydrodynamic Thrust Bearing," ASME *Trans.*, Vol. 72, No. 4.

THE aluminum industry produces about 1.25 billion pounds of pure aluminum yearly, requiring the use of 12.5 billion kw hours of electricity. Aluminum has more than 4000 uses and is a basic raw material for more than 17,000 businesses in the United States, employing approximately one million persons.

Nomographic Design of Helical Springs

By John H. Keyes
Design Engineer
Dempsey Pump Co.
Tulsa, Okla.

DESIGNERS frequently feel the need of a quick and simple means to determine the specifications of springs to fit their requirements. The nomogram on the following page, especially prepared for this purpose, will satisfy most needs although it may need to be supplemented in certain critical applications.

Most designs call for springs that can be classified roughly in three groups: (1) those that are limited by available space, (2) those that must meet certain performance data and (3) those that must meet both these requirements. The chart presented in this article provides a means for determining the dimensions of a steel helical spring to meet a given specification of load and travel, and the behavior of a spring to fit within a given space.

The nomogram is based on the standard formulas for the design of springs:

$$y = \frac{8PND^3}{Gd^4}$$

$$s = \frac{8PKD}{\pi d^3}$$

$$K = \frac{4c - 1}{4c - 4} + \frac{0.615}{c}$$

Nomenclature

c = Spring index
$= D/d$
D = Pitch diameter of coil, inches
d = Diameter of wire, inches
G = Shear modulus, psi (11,000,000 for steel)
H = Free height, inches
h = Solid height, inches
K = Stress correction (Wahl) factor for curvature
N = Number of active coils
P = Spring load, pounds
s = Shear stress, psi
y = Total deflection, inches
y/NP = Deflection per coil per pound of load
P/y = Spring rate
s/P = Stress in wire per pound of load

EXAMPLE: Determine the dimensions of a spring which will fit loosely in a 1-inch hole, have a spring rate of 20 pounds per inch and develop a stress of 125,000 psi at maximum compression.

By inspection and trial select values for D and d that give an outside diameter of about 0.950 inch and a favorable spring index. Index Line 1 is drawn through a set of values meeting these requirements: $D = 0.875$, $d = 0.105$, $c = 8.5$, and $y/NP = 0.004$.

Index Line 1 gives also an intersection with reference scale A. Through this intersection and the value for K corresponding to the indicated value of c, draw Index Line 3, finding $s/P = 2235$.

Through this point and that for 125,000-psi stress, draw Index Line 2, finding, as a maximum, $P = 56$ pounds.

With this point and that for the given spring rate, $P/y = 20$, draw Index Line 7, finding $y = 2.8$ inches, total travel.

This value of y, together with $y/NP = 0.004$, found by Index Line 1, locate Index Line 5 to give an intersection with reference scale B.

From this point on B, and $P = 56$ found on Index Line 2, draw Index Line 4, finding $N = 12.6$ active coils.

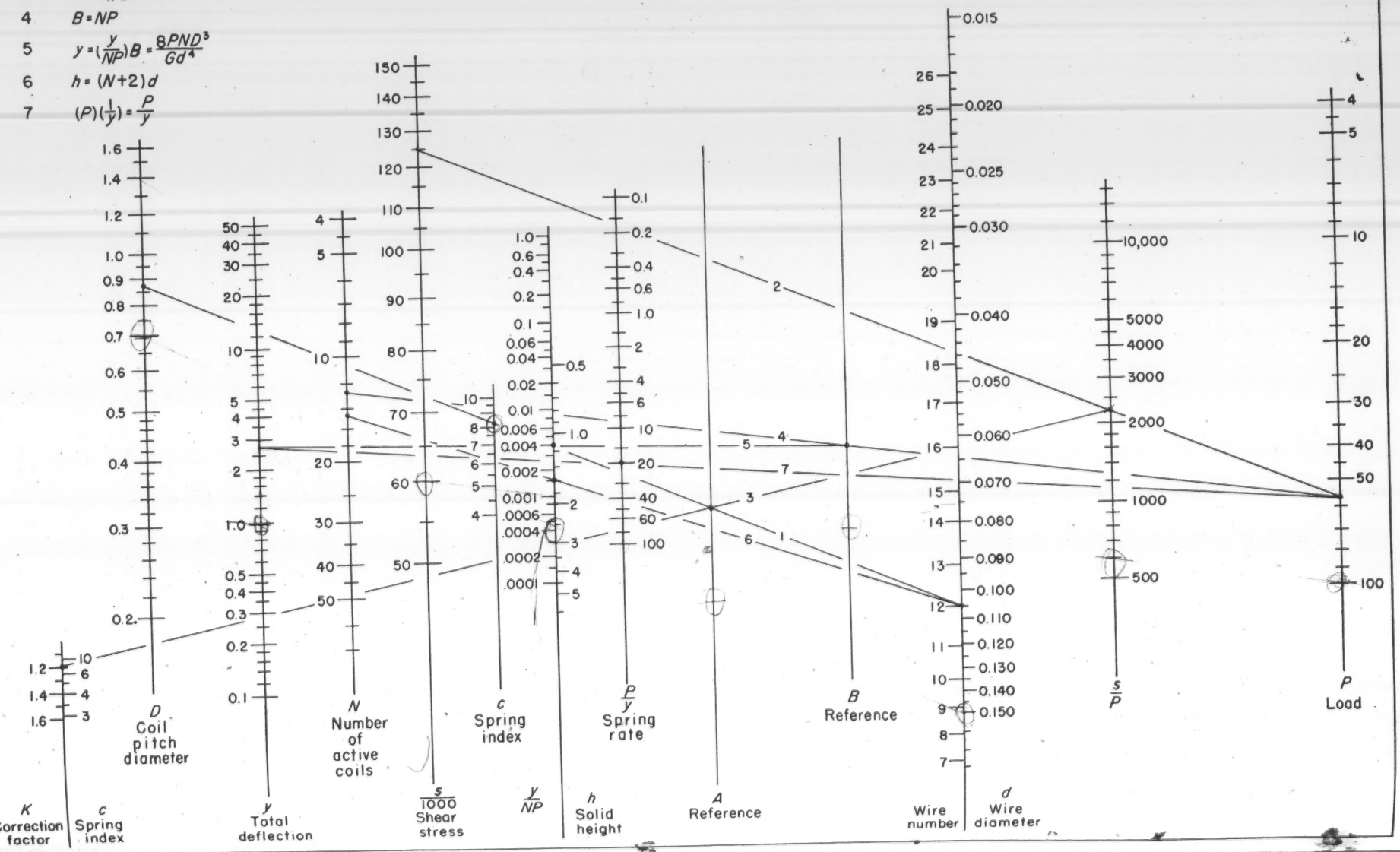
If it is assumed that the spring will have two inactive coils, draw Index Line 6 from $N = 14.6$ to the point, $d = 0.105$, found by Index Line 1, finding $h = 1.53$ inches, solid height.

The data show that: solid height, $h = 1.53$, spring travel, $y = 2.80$; and their sum, free height, $H = 4.33$.

Thus a complete picture of the spring is given, sufficiently accurate for the designer to plan the accompanying parts of his device to accommodate it. A similar procedure can be followed to solve other types of problems. By starting with the known or required specifications, whether of dimension or of behavior, and by drawing the index lines determined by them, the designer can follow line by line until he finds a value for each characteristic. In many cases, as in the problem discussed, several solutions can be found. The designer must rely on his best judgment, often with no help from the nomogram, to select the most suitable.

Chart for Designing Helical Springs

Index line*	Formula
1	$\frac{y}{NP} = \frac{8D^3}{Gd^4}$ $\quad A = \frac{8D}{\pi d^3}$
2	$(s)(\frac{1}{P}) = \frac{s}{P}$
3	$AK = \frac{8DK}{\pi d^3} = \frac{s}{P}$
4	$B = NP$
5	$y = (\frac{y}{NP})B = \frac{8PND^3}{Gd^4}$
6	$h = (N+2)d$
7	$(P)(\frac{1}{y}) = \frac{P}{y}$



DESIGN ABSTRACTS

Gas Turbine Truck

By W. M. Brown
Kenworth Motor Truck Corp.
Seattle, Wash.

A GAS turbine is a heat engine which utilizes the expansion from the combustion of fuel and air in a combustion chamber by transforming that energy directly into either thrust or shaft power. The expanding gases are directed against a turbine wheel driving a rotary compressor which crams an excess of air into the combustion chamber. The products of combustion after leaving the compressor wheel may be directed through a nozzle, producing jet thrust. Or, as in the case of the Boeing Truck Turbine, they may be directed against a secondary turbine wheel, the shaft of which, driving through reduction gears, produces shaft power.

The model 502 shaft-power turbine here discussed was developed by the Boeing Airplane Co. under the sponsorship of the Navy Dept., Bureau of Ships. For test in ground vehicle propulsion, the unit was installed in a Kenworth truck chassis. Some potentials of this type of application have been revealed by preliminary evidence.

Though the gas turbine is far from a perfect heat engine, its basic principle is that of the conversion of the products of the combustion of fuel directly to rotary shaft power with the absence of any reciprocating motions in producing either thrust or shaft power. The advantage of obtaining rotary power without reciprocating motion has long been recognized, but it has been only within recent years that techniques have been understood and materials available to accomplish this.

The entering air is compressed by a centrifugal blower and discharged past fuel injection nozzles in cylindrical combustion chambers where continuous combustion takes place. The products of combustion of the two chambers are directed through a primary turbine where two thirds of the energy of the gases is extracted in turning the compressor shaft. The remainder of the gas is led through a secondary turbine where shaft power is produced. The compressor shaft turns at 36,000 rpm at full power; the secondary turbine turns at 22,650 rpm and drives through 9.06 to 1 reduction gearing, resulting in an output shaft speed of 2500 rpm at rated power and speed.

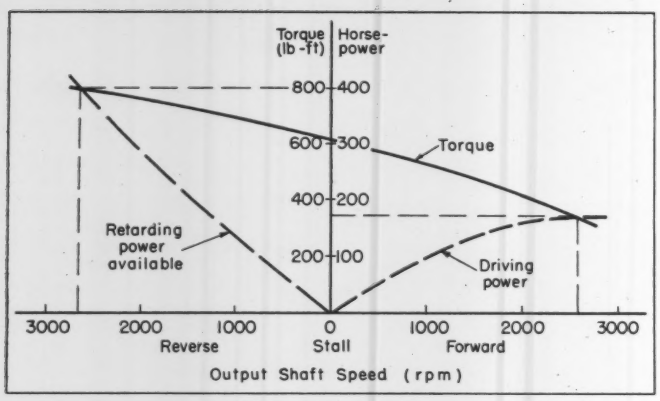
Advantages of the gas turbine are as follows:

1. Light weight. The complete unit weighs slightly more than 1 pound per horsepower
2. Small installation space required
3. Few component parts, particularly moving parts. Only 10 per cent as many parts as the average reciprocating engine
4. Absence of vibration
5. Adaption to many low-grade, nonexplosive fuels. Octane and cetane numbers do not influence the fuel's useability
6. Easily maintained with a minimum of man hours required to service the engine
7. Good cold weather starting characteristics, once ignition takes place. Some trouble has been experienced with initial vaporization at the fuel nozzles with low temperatures
8. Absence of ignition system, except in starting
9. Maximum fuel economy with maximum engine output
10. Low consumption of lubricating oil
11. Absence of external cooling system
12. Clean exhaust
13. Less objectionable exhaust noise.

Offsetting the advantages, there are the following disadvantages:

1. Higher fuel consumption than piston engines in all ranges
2. Poorest fuel economy in part-throttle operation
3. High rotative speeds of moving parts
4. Parts most subject to failure are high-cost items
5. Materials for some of the important components are high-cost, hard-to-obtain.

Of particular interest to automotive applications is the torque characteristic of the secondary turbine wheel, or driving unit. No mechanical connection exists between the compressor unit and the second-stage turbine unit. This feature allows the compressor unit to operate independently from the second-stage turbine unit, the only connection between the two being that of gas pressure. The secondary turbine wheel has torque characteristics which allow it to develop twice the normal operating torque when the wheel is stalled. In effect, the engine is also a torque converter with the ability to multiply torque progressively with decreasing speed until almost two



to one is reached at stall. This combined engine and torque converter is not penalized by the extra weight that usually goes with a torque converter installation.

It will be recalled that oil torque converters are limited in sustained torque multiplication by the heat rejection capacity of the converter cooling system. In automotive applications, sufficient cooling is provided for sustained operation above 70 per cent efficiency. Below 70 per cent efficiency, the duration of converter action is progressively more limited. This limiting factor does not necessarily hold with the gas turbine. As far as is known now, the secondary turbine can be held continuously at stall. Under this condition a slight increase in stack temperature occurs.

Characteristics of shaft speed versus torque and power are shown by the accompanying graph. The upward curving torque curve starts at the lower right at maximum speed torque, and slopes up to the stall point where the torque is almost doubled. As it extends to the left, the slope becomes less pronounced as full retarding power is approached. Horsepower available for driving the truck is shown on the right-hand side of the vertical scale. To the left of the vertical scale is plotted horsepower available for retarding—holding constant-grade descent speed. The retarding feature is unique inasfar as is known to date, and has every possibility of developing into a system which will greatly reduce the load on the service brake system of any vehicle so equipped. Lining wear will be reduced at the expense of increased fuel consumption since gas pressure produces the resistance to turbine wheel rotation.

It is interesting to note that the horsepower available for retarding roughly corresponds to a 4.5 per cent grade descent with 68,000 lb gross combined weight, the vehicle traveling at constant speed (without deceleration). The maximum horsepower available for hill climbing is 175 which will allow the vehicle to ascend an adverse 6 per cent grade at 9.3 miles per hour with 68,000 lb gross weight.

Future plans for the engine as a truck power plant call for a combination reduction gear and reverse gear in one box at the rear of the secondary unit. The output shaft in this new reversing box will drive through a pair of universal joints into a planetary transmission with six forward speeds and no reverse. The shaft of this transmission will drive directly into the rear axle assemblies. For the average highway freight job, an auxiliary transmission is not contemplated. It can be demonstrated that, by the proper spacing of gear ratios, sufficient top speed and sufficient gradeability in the lowest gear can be obtained without the use of an auxiliary transmission.

From a paper presented at the SAE National West Coast Meeting in Los Angeles, August 14-16, 1950.

Correction

In the abstract "Titanium and Zirconium Fabrication," which appeared in this section of the October issue, the authors were incorrectly identified through an error in makeup. The original paper was written by A. M. Bounds, Chief Metallurgist, and H. W. Cooper, Metallurgist, Superior Tube Co. To them and our readers, we apologize for this regrettable error.—THE EDITORS.

The Engineer's Stake In Public Relations

By John D. Waugh
Pendray & Leibert
New York, N. Y.

COMPARED to the struggles of other professions for favorable public recognition, engineering is twice blessed. Both its origin and its recent past have bequeathed it a favorable though not prominent public standing. In the minds of people who understand the creed, philosopy and contributions of engineering, the collective image of the profession is a positive one of objective research, constructive effort and service to mankind.

In spite of the generally favorable standing of engineering, there is evidence that the profession is not fully understood and appreciated by the general public. If you were to take a poll of passers-by on the street, asking each of them to name a great engineer, chances are they would scarcely be able to name one. Yet, most of these people could unhesitatingly name a great general, or a great statesman, or a poet, or actor, or even a great scientist.

At the community level there is widespread misunderstanding of an engineer's function, whatever his field. It has been said that an untold number of wives, when they state that their husbands are engineers, are asked, "With what railroad?" When exact titles are given, such as "stress analyst at the Concrete Airplane Corporation," members of the lay public still do not know what the engineer does. They are not interested in, and will not remember, unusual technical titles. They understand that doctors heal the sick, lawyers guide people's legal relationships, mechanics fix things, and so on. They will have to be told what engineers do to appreciate their place in the scheme of things.

Also in the community there appears to be an insufficient proportion of engineers who take the lead

in civic projects, organize worth-while activities, or speak before important civic groups. Program committees often consider technical people a bit dull and pedantic. If an engineer is suggested as a speaker, someone will tell about an engineer he knows, Harry Hemisphere. It is recounted that Harry won't say a ball is round, but will say: "It appears to be round at the prevailing temperature and under existing light conditions, but, without having proper instrumentation and criteria for round balls, I cannot risk my professional integrity by stating the ball is round."

Though this characterization may be overdrawn, there are many engineers whose analytical talents render them virtually inarticulate and hardly candidates for speaking appearances.

Companies, schools, and local and national engineering societies frequently find it difficult to get eminently qualified engineers to write interesting papers and present them effectively. Lay groups experience the same reticence. One result of this reluctance to lead is that the professional standing of engineering slips relative to the standing of other more active groups. Doctors and lawyers are social, civic, and political minded because their living depends directly upon the symbol they and their professions maintain.

Students at engineering schools periodically follow "fads" for certain branches of engineering that threaten the college with overstaffing in one field and shortages in others. At the seat of this difficulty is the failure of the profession, collectively, to present accurately the opportunities existing throughout engineering. Every engineer has a vested interest in the appropriate distribution of his fellow members throughout the profession. It there is disillusionment or displacement of engineers, or the profession loses its allure for capable young men, its future growth and standing are imperiled.

Organization and Machinery Available

To meet the problems facing their profession, engineers can undertake a program within the scope of their present activities by applying well-known public-relations principles. The profession is fortunate in having the organization and machinery to conduct a successful program for greater public recognition and appreciation. The national societies, with their experienced headquarters staffs and their network of chapters, form the ready-made organization. The machinery is provided by the general-circulation engineering publications, national, regional, and local-meetings programs and flow of paper presentations. What is needed additionally is a representative expression by members that they recognize their stake in public relations and want to do something about it.

An engineering public-relations program should include these objectives:

1. To gain wider public recognition of the role of the engineer in modern society. This would help maintain the prestige of the profession and assure its attraction for the best-qualified young men
2. To take definite steps in meeting threats to the profession. By clarification of the requirements and definition of the limits of the profession, shadowland "engineers" can be discouraged from using unqualified titles
3. To inform engineers how their stake in public relations has a direct bearing on their income and the security and prestige of their positions. The values of participating in social, economic, and political affairs at all levels would be emphasized.

If the engineering profession ever decides to follow a plotted course of improving its public relations, it will again be twice blessed: Because it has done tremendous good and promises to do very much more, and because it is not a pressure group, and the only axe it has to grind is that it wants to be known for the good work it has done and is doing.

From a paper presented at the ASME Fall Meeting in Worcester, Mass., September 19-21, 1950.

Styling Machine Tools

By Frank Burgess and Harold Sizer
Brown & Sharpe Manufacturing Co.
Providence, R. I.

ARE those who buy or specify machine tools influenced by appearance? Purchasers have long prided themselves on their practical evaluation of machine tools. They want facts—demonstrations of production rates, samples showing accuracy and surface finish, lubrication diagrams, material specifications, and assurances of long service life. Does appearance play any part in this practical appraisal? We believe it does.

A well-styled machine creates interest, and a buyer is ready to listen to the story of what the machine can do. The styling also can do a subtle but effective job in emphasizing the features of a machine. If a concern is offering a powerful machine, sturdy and rigid, with a reserve of power for tough cuts, the styling can suggest these qualities, and by its presentation of masses create the feeling of power or strength. Similarly, if a small "light-type" machine is being offered, which is sensitive and easily operated, the styling can subdue mass effects and suggest the light, responsive qualities it is desired to emphasize.

Function: In machine tools the practical requirements of the design come first, and function is not sacrificed or compromised for appearance. If 1 hp is needed, we cannot adapt a ½-hp motor just because it gives a more compact better-proportioned appearance on the machine column. If the convenient working height of a machine table is 40 inches above the floor, we cannot, like the artist painting bathing beauties, increase leg lengths to get more pleasing proportions.

The supremacy of function makes the job of a machine-tool stylist a difficult one. In general, little can be done by a final face lifting, and machines with after-thought ornamentation or "draped-on" effects show a lack of sincerity. The appearance so

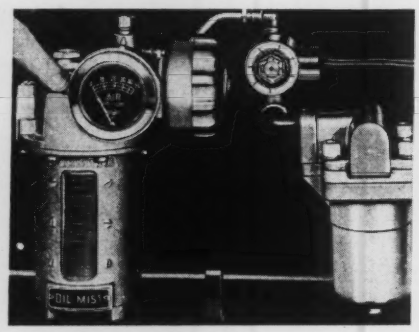
(*Continued on Page* 208)

NEW PARTS AND MATERIALS

. . . presented in quick-reference data sheet form for the convenience of the reader. For additional information on these new developments, see Page 191

Centralized Lubricator — 1

Alemite Div., Stewart-Warner Corp., Chicago, Ill.



Designation: Oil-Mist

Style: Model 4955, air-lubricant mist, automatic solenoid controlled

Size: Lubricator—height 8½ in., width 6½ in., depth 4⅝ in., with solenoid valve—height 8⅝ in., width 6½ in., depth 4⅞ in.; air inlet, ¼-in. female PT; mist outlet, ⅜-in. female PT; water separator—height 6 in., width 3⅜ in., depth 3½ in.; inlet and outlet, ¼-in. female PT

Service: Shop air, 10 to 20 psi pressure, max consumption approximately 1 cfm; solenoid, 115 v a-c; up to 30 bearing inches (bearing inches = bearing ID, in.) per lubricator with 60 bearings max

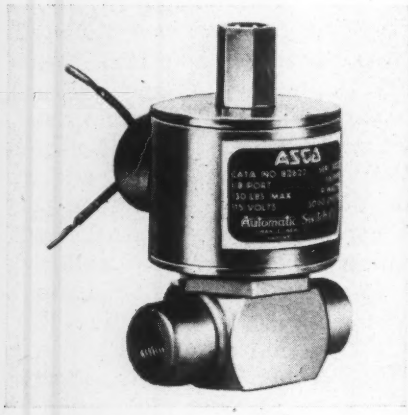
Design: Air pressure regulator; needle valve oil flow control; air to lubricator solenoid controlled; oil can be delivered to bearings as mist or precipitated at point of delivery to solid oil

Applications: Automatic controlled delivery of lubricating oil to all types of machine bearings—ball and roller, plain, sliding, or rolling.

For more data circle MD 1, Page 191

Three-Way Midget Valve — 2

Automatic Switch Co., 379-C Lakeside Ave., Orange, N. J.



Designation: Asco

Style: Packless, three-way universal, solenoid

Size: ⅛-in. pipe ports with $\frac{3}{64}$-in. flow hole; fits within 3½-in. cube; shipping weight, 1¼ lb; conduit connection, ½-in. IPS

Service: Air, gas, water, light oil, refrigerants and other fluids to 212 F; pressures to 125 psi (a-c), 50 psi (d-c); 115/230 v a-c 60 cycle, 115 v d-c; power consumption, 10 watts

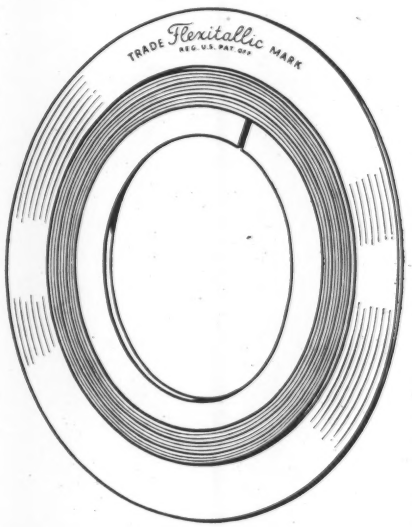
Design: Mounts in any position; body—brass or stainless steel bar stock; valve seat—crown type integral with body; valve disc—flat synthetic composition, chemical resistant; solenoid coils—NEMA Class B, 24-in. leads; conduit connection revolves 360 deg.; can be disassembled without removing from line

Applications: Fluid control circuits for diaphragm motors, measuring and testing apparatus, power cylinders; oil burners, gas heaters, dispensers, etc.

For more data circle MD 2, Page 191

High-Pressure Gasket — 3

Flexitallic Gasket Co., Camden, N. J.



Designation: Flexitallic

Style: CGI, compression gage type, inside and outside ring

Size: All standard ASA and API fittings; special available; inside ring thickness varies with flange finish and gasket yield factors

Service: Hydraulic and highly corrosive fluids from 150 to 2500 psi

Design: Spiral-wound construction with alternating V-crimped plies of metal and filler in wide choice of materials including Teflon; solid reuseable inside rings prevent radial movement of gasket under high bolt loads, minimize contamination from fluids, fill flange recess to prevent flow turbulence—made of stainless steels, Monel, nickel, or Inconel

Applications: Compression flange sealing for fluid handling systems.

For more data circle MD 3, Page 191

Bond Testing of Bi-Metallic Bearing Materials-2

IN Part 1-Bond Testing of Bi-Metallic Bearing Materials we pointed out the importance of securing a definite *bond* between two or more metals in the production of quality bearings. While the only reliable tests available at this time are destructive in nature, they serve as an accurate gauge of quality during the manufacturing process. The test most widely used is the chisel test—Figure I.

If the alloy layer can be detected both on the overlay and the base metal, brittle bond is indicated. If the overlay metal is stripped clean from the base metal, then the bond is bad rather than brittle.

Tables II and III outline rating methods which can be employed to classify the results of the chisel test.

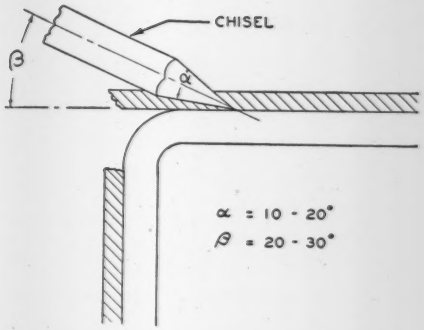


Figure 1—Chisel Test of Bond Bi-Metallic Bearing Materials

TABLE II

Bond Ductility Rating

Bond Number	Rating	Percent of Overlay Metal Fractured Along Bond Line
1	Good	0- 5
2	Good	5- 15
3	Fair	15- 40
4	Poor	40- 60
5	Bad	60-100
6	Bad	100

TABLE III

Bond Completeness Rating

Bond Number	Rating	Appearance of Chisel Marks
1	0	No tendency of two metals to separate.
2	0- 15	Separation at edge of chisel marks.
3	15- 40	Bond separates in spots.
4	40- 60	About 50% of base metal cleanly exposed.
5	60-100	More than 50% of base metal exposed.
6	100	Base metal completely exposed.

Lead alloys should have a bond number of 1 on steel backs, although with lead base babbitts containing tin, a bond number of 2 may be obtained. Tin alloys on steel usually have a bond number of 2 while on bronze the bond number may be 3, due to the fact that heavier layers of the brittle tin-copper compound are formed.

The presence of a brittle bond in a composite bearing material is not undesirable as long as the bond strength is high and the bearing is not subjected to heavy fatiguing stresses. Fatigue loads, which are of a cyclical, repetitive nature tend to flex the material back and forth, which flexing induces shear stresses in the bond layer. Brittle bond compounds are usually weak in shear strength, but in some cases, it has been found that material with a bond rating of number 4 will perform satisfactorily in bearing applications. This is especially true of material such as bushing stock fabricated by sintering bronze powder on a steel backing. The bonding is not complete due to the natural porous structure of the bearing metal.

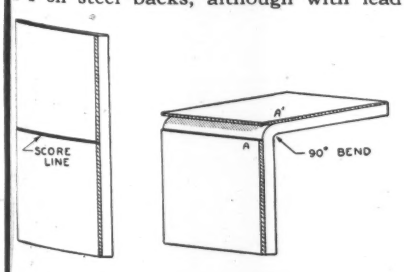


Figure 2—Preparation of sample for "Peel-Back" Test

Also, the semi-quantitative value of the test does not signify that bond number 2 is faulty and, in many cases, a bond number of 3 is entirely acceptable.

Further interpretation of bond strength by the chisel method is possible with the aid of a "peel-back" test. In this test, the specimen is bent 90 degrees on the backing metal which flexing promotes shear along the bond line and enables the tester to study the type and quality of the bond more thoroughly.

The "peel-back" test is illustrated in Figure II. The piece to be tested is placed in a special fixture, notched along the bearing surface and bent back over a fixed radius. The stretching action along the arc of the bend causes shear stresses to be set up in the bond layer. If the bond is brittle or weak, the overlay will tear loose and can be peeled back. The distance A-A' that the metal peels back is one indication of the bond strength and quality. Further interpretation can be made by chiseling into the overlay from point A'.

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

This bearing data sheet is but one of a series. You can get the complete set by writing to—

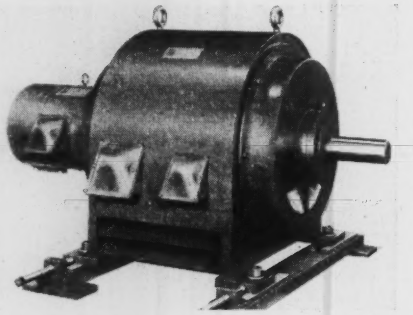
Johnson Bronze

SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

NEW PARTS AND MATERIALS

Synchronous Motor 4

Electric Products Co., 1725 Clarkstone Rd., Cleveland 12, Ohio.



Style: Synchronous, open, dripproof, splashproof, weatherproof; bracket, pedestal or flange

Size: 20 hp and up

Service: 514 rpm and up; 0.8 leading p.f.; any commercial d-c power supply

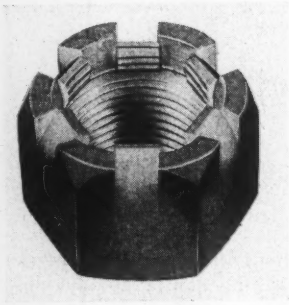
Design: Welded all-steel construction; special varnish insulation; one-to-one ratio pedestal bearings; adjustable slide belt tightening

Applications: For high-speed heavy-duty and special machine drives.

For more data circle MD 4, Page 191

Lock Nut 6

Boots Aircraft Corp., Stamford, Conn.



Designation: Hex-Lok

Style: Nut, hex head, locking

Size: 8-32 to 3/8-24

Service: Cadmium-plated steel for spec AN-N-5 to 250F and AN-N-10 to 550F; silver-plated stainless steel for 1200F; torque values controlled to special requirements

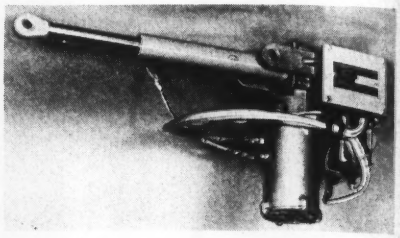
Design: Six threaded flanges depressed inward and downward for locking; vibration resistant

Applications: For all types of vibration-resistant fastening requirements on machinery.

For more data circle MD 6, Page 191

Actuator 8

Hydro-Aire Inc., Burbank, Calif.



Style: Linear, electromechanical

Size: Retracted overall length, 10.31 in.; height, 5.375 in.; width, 3.218

Service: 200 lb axial compression, 100 lb tension; piston travel, 2.31 in.; operating time, either direction, 8 seconds; duty cycle, one minute on, 15 minutes off; ambient temperature range, −100F to 165F; current drain, 2.5 amp; 115v a-c, single-phase 400-cycle

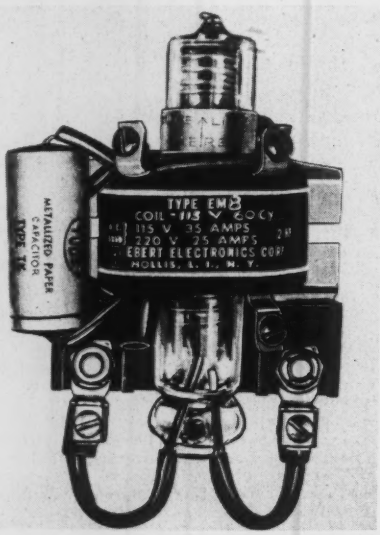
Design: Integral brake stops overtravel within 0.02-in. after power cutoff; positive nonjamming stops; adjustable load limit switches

Applications: For operation of carburetor preheat valves, turbo selectors, air shutters, etc.

For more data circle MD 8, Page 191

High-Power Relay 5

Ebert Electronics Corp., 185-09 Jamaica Ave., Hollis 7, L. I., N. Y.



Style: EM-8, Mercury plunger type

Size: 4¼ in. high, 2⅝ in. wide, 2¼ in. deep

Service: Load, 35 amp 115v, 30 amp 220 v, 20 amp 440 v; unlimited inrush current; external contact power, 100 v, 8 ma a-c; power amplification, 10,000

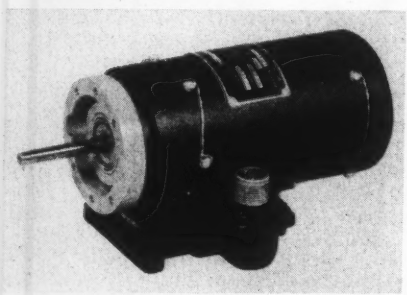
Design: Hermetically sealed mercury to mercury; energizing coil in resonant circuit; external contact merely detunes resonant circuit

Applications: Machine electric and electronic control circuits.

For more data circle MD 5, Page 191

High-Speed Motor 7

Lear Inc., 110 Ionia Ave., NW, Grand Rapids, Mich.



Style: Model CA-14B-3; flange or base mounting

Size: 1/15 hp; 3.08 x 3.72 x 5.06 in. long; weight, 2.44 lb

Service: Continuous duty, 4600 rpm; starting torque, 385% full-load torque; 26 v d-c; ambient temperature range, −65 to 165F

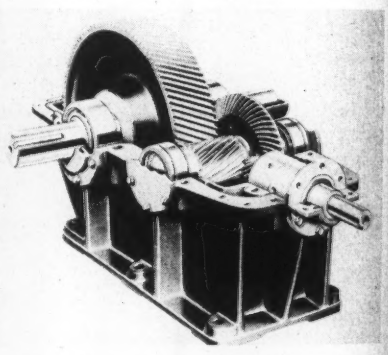
Design: Precision built for severe duty; corrosion resistant; optional features—clutch for positioning of friction load devices, electromagnetic brake for positioning control in applications which require locking or impose large load inertias on motor, thermal protector for maximum stress or overload conditions, radio noise filter to meet ANM-40 specs

Applications: High-speed precision control drive for aircraft and industrial equipment.

For more data circle MD 7, Page 191

Speed Reducer 9

The Falk Corp., Milwaukee, Wis.



Style: Right-angle, horizontal; GHB-single reduction, GDB-double reduction, GRB-triple reduction

Size: 15 to 1500 hp

Service: Occasional, intermittent or continuous duty; reduction—1.5:1 min., 515:1 max; input—1750 rpm and higher

Design: Shafts—heat-treated alloy steel in small sizes, SAE 1045 forged steel in large sizes; bearings—a straight roller and two tapered roller for high-speed shafts, double row tapered for sprocket or pulley connected low-speed shafts, tapered roller all other shafts; gears—spiral bevel precision cut carburized and lapped in first reduction, single helical precision cut and shaved in other reductions; lubrication—continuous splash system

Applications: General purpose and special machine drives.

For more data circle MD 9, Page 191

Genuine ALEMITE LUBRICATION FITTINGS

DATA SHEET NO. 3

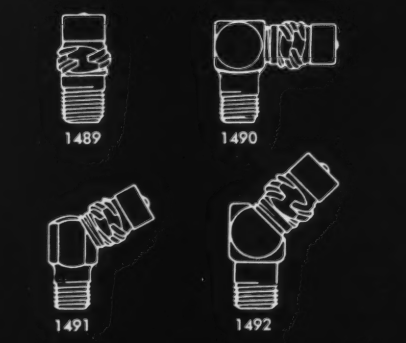
Simplify ORDERING, INSPECTION and INVENTORY CONTROL. Specify Alemite part numbers on your blueprints.

Useful Information to Help You Select and Specify the Right Alemite Fitting for Every Bearing

PIN TYPE FITTINGS

The original lubrication fitting developed by Alemite. Named after the positive locking of the Pin Type Coupling on the cross pin of the fitting.

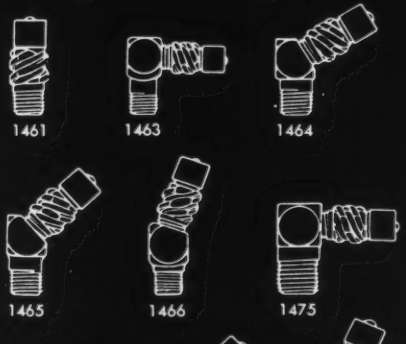
PART NO.	THREAD SIZE	FITTING ANGLE	LENGTH OVERALL
A-336	1/8" P.T.	Straight	1"
M-336	1/8" P.T.	Straight	1"
A-359	1/4" P.T.	Straight	1 9/32"
A-358	1/8" P.T.	90°	1 1/16"
A-850	1/8" P.T.	Straight	1 31/64"
A-684	1/8" P.T.	45°	1 9/16"



MOGUL DOT FITTINGS

Similar to the Dot Fittings above, except larger and more rugged to withstand hard industrial use on heavy machinery.

PART NO.	THREAD SIZE	FITTING ANGLE	LENGTH OVERALL
1489	1/4" P.T.	Straight	1 7/16"
1490	1/4" P.T.	90°	1 11/32"
1491	1/4" P.T.	60°	1 21/32"
1492	1/4" P.T.	45°	2"



STANDARD DOT FITTINGS

Commonly used on heavy duty machinery such as contractors' equipment, wood working machinery, canning machinery, etc. Gun coupling screws on to the fitting thread, making a positive seal.

PART NO.	THREAD SIZE	FITTING ANGLE	LENGTH OVERALL
1461	1/8" P.T.	Straight	1 15/64"
1463	1/8" P.T.	90°	1"
1464	1/8" P.T.	60°	1 15/32"
1465	1/8" P.T.	45°	1 21/32"
1466	1/8" P.T.	20°	1 13/16"
1475	1/4" P.T.	90°	1 3/16"
1476	1/4" P.T.	60°	1 7/16"
1477	1/4" P.T.	45°	1 21/32"
1478	1/4" P.T.	20°	1 7/8"

ALEMITE

Modern Lubrication Methods That Cut Production Costs

FREE! Complete set of four Data Sheets similar to this, giving specifications on all types and sizes of Alemite Lubrication Fittings. Simply write to Alemite, Dept. R-120, 1850 Diversey Parkway, Chicago 14, Illinois.

Another Product of STEWART WARNER

NEW PARTS AND MATERIALS

Braided Packing 10

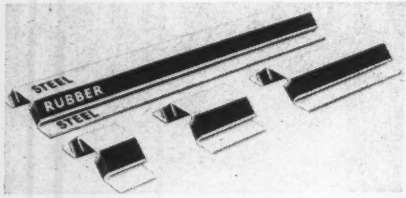
Greene, Tweed & Co., North Wales, Pa.

Designation: Palmetto 1330
Form: Braided blue asbestos yarn impregnated with Teflon
Size: From ⅛-in. sq. and up; 1-lb spools, 5½ and 13-lb boxes, or 25, 50 and 100-lb reels
Service: Corrosive chemicals and solvents from −150F to 550F
Properties: Easily cut or formed; high chemical resistance; self-lubricating; leakproof
Applications: Fluid handling systems; chemical processing.

For more data circle MD 10, Page 191

Vibration Mount 12

Finn & Co., 2850 Eighth Ave., New York 30, N. Y.

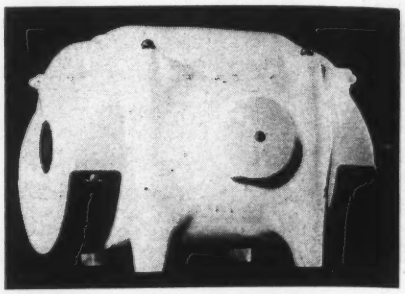


Designation: Finnflex
Style: No. 9 channel type
Size: Any length to 18 in.
Service: Vibration damping; four rubber stiffnesses for loads of 40, 50, 70 and 105 lb per in. length at ¼-in. deflection
Design: Steel channel floated in rubber between two steel angles; spring index is not constant, resonance avoided
Application: Isolating all types of machines and equipment against vibration.

For more data circle MD 12, Page 191

Sanitary Motor 14

U. S. Electrical Motors Inc., 200 Los Angeles 54, Calif.

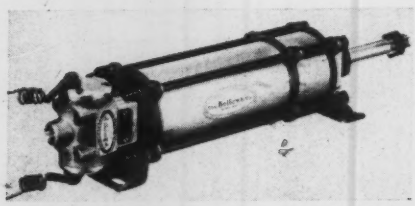


Style: CT, totally enclosed, foot or flange mounted
Size: ½ to 2 hp
Service: 1800 rpm; 55C temperature rise; a-c
Design: Baked white enamel finish; smooth self-draining exterior; sealed terminals; water sealed bearings; asbestos protected windings; rustproof fittings; hollow feet for through stud mounting; full clearance under motor for cleaning
Applications: Drives for food processing and handling machinery.

For more data circle MD 14, Page 191

High-Speed Air Motor 11

Bellows Co., Akron, O.

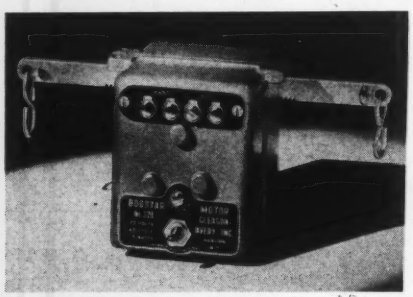


Style: BSSM Series double-acting cylinders; electronic or manual control valve; foot, pivot or front flange mountings; rear flange, foot or pivot with remote control
Size: Stroke lengths, 4, 6, 9 or 12 in; bores, 2½ or 3⅝ in.
Service: Air pressures, 60 to 100 psi recommended, 5 to 175 psi max., rod speeds 6 to 10 times standard cylinder speeds; power to punch ½-in. hole in 1/16-in. mild steel
Design: Built-in accumulator and quick-release valve; integral directional valve; built - in operating and speed controls; high-speed advance, slow retreat strokes, both high-speed strokes special
Applications: For machines requiring high-speed high-power strokes for staking, riveting, forming, swedging, and punching operations or for cutting of continuously moving materials such as in extruding and for flash trimming of moldings or castings in plastics or metals.

For more data circle MD 11, Page 191

Control Motor 13

Gleason-Avery Inc., Auburn, N. Y.

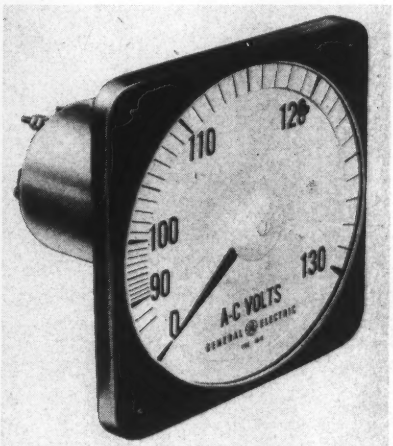


Designation: Boostar
Style: Enclosed motor, rack and automatic safety return; straight-line operation
Size: 3½ to 3¾ in.; weight, 3 lb
Service: Automatic heat control and control during power failure; power lifts approximately 23 lb (direct pull) 4 in. in 30 seconds; requires 3 to 5 lb spring; primary excitation, one watt; 110 v 60-50 cycles a-c
Design: Chassis mounts in any position; all terminals housed outside case; external transformer; oil-retaining bronze bearings; circuit closed — motor driven rack moves to left, circuit open (power failure)—spring returns rack bar to right
Applications: Shut off use, air conditioning applicators, door operation, furnace fire control, etc.

For more data circle MD 13, Page 191

Voltmeter 15

General Electric Co., Meter and Instrument Divs., Schenectady 5, N. Y.

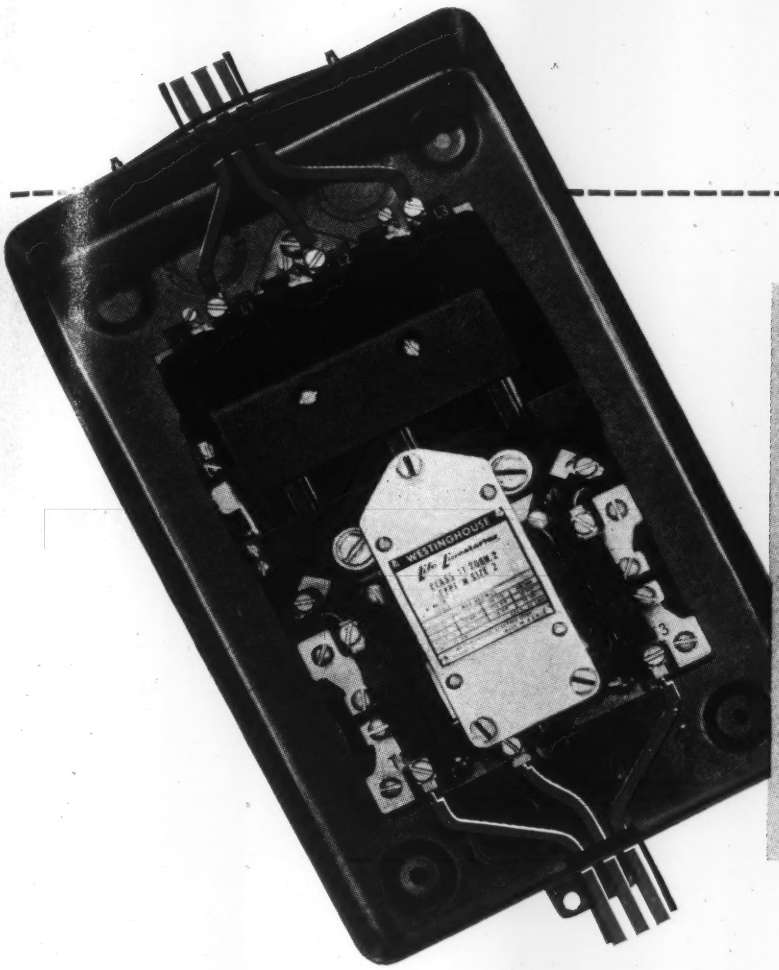


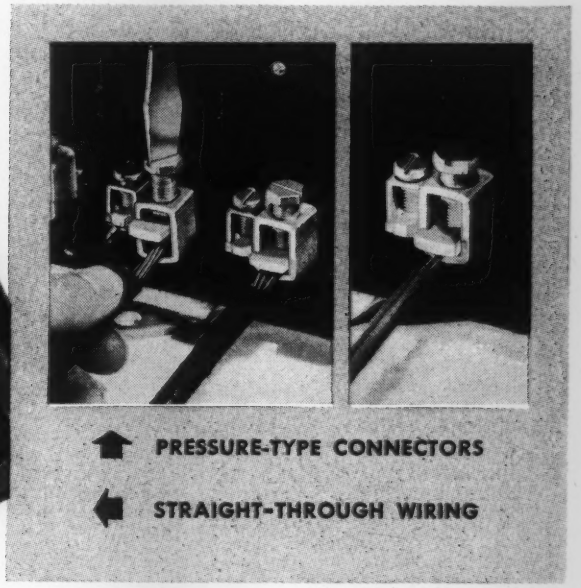
Style: AB-16 (a-c); DB-16 (d-c)
Size: 8¾ in. square; scale, 250 deg., 14.2 in. long
Service: Long-range reading, 130 v
Design: Protruding convex glass cover for flush mounting; shock-resistant spring-mounted jewels; magnetic damping for quick response; dustproof, moisture-resistant cases having steel shell with Textolite base and die-cast cover
Applications: For use on swinging brackets or other installations remote from the control station.

For more data circle MD 15, Page 191

YOU CAN BE **SURE**.. IF IT'S

Westinghouse





*NEW Life-Linestarter**

cuts installation costs 4 ways!

Savings start before they are put in operation . . . with the new Westinghouse Life-Linestarter. New design features permit faster, easier installation—

1. **Straight-through Wiring**—Plainly marked line terminals are *all* at top—load terminals *all* at bottom, permitting simple, straight-through wiring with uniform lead lengths. All terminals are easily reached from the front.
2. **Pressure-type Connectors** speed the job and provide a positive low-resistance connection for either solid or stranded conductor, in a range of sizes to cover all ratings.
3. **NEMA Standard Mounting**—Open starter units conform to the new NEMA mounting dimensions, also to the NEMA sequence of wiring, permitting interchangeability.
4. **Deep-drawn Lift-off Cover**—Exposes unit for easy access. Fastens securely. May be padlocked. No hinge trouble.

The Life-Linestarter cuts costs in other ways, too—uniformity and completeness of line (NEMA sizes 0 through 4, to 100 hp, 600 volts) . . . superior performance . . . positive protection. Ask your Westinghouse representative to show you "the inside story"—a Trans-Vision presentation. Or write for booklet B-4677. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-30025

*Trade Mark

Westinghouse

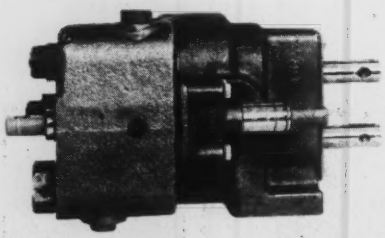
Life-Linestarter

TOMORROW'S STARTER—**TODAY!**

NEW PARTS AND MATERIALS

Hydraulic Pump-Valve 16

Commercial Shearing & Stamping Co., Youngstown, O.



Style: B101 series; pump and control-valve combination

Size: 1½, 2, 2½ in. pipe ports

Service: Intermittent oil hydraulic duty to 1500 psi

Design: Two drive shafts for connection to power take-off shaft having either rotation; push-pull balanced-spool control valve with raise, hold and lower positions; optional relief valve if desired—single-stage or two-stage

Applications: Actuating hydraulic dump units, etc.

For more data circle MD 16, Page 191

Phenolic Laminate 18

Richardson Co., 2793 Lake St., Melrose Park, Ill.

Designation: Insurok, T-812

Form: Paper-base phenolic laminate sheet

Size: Wide range of sheet sizes and thicknesses

Service: High-frequency insulation; resistance, 1,000,000 megohms ($\frac{1}{16}$-in. sheet) after humidity conditioning

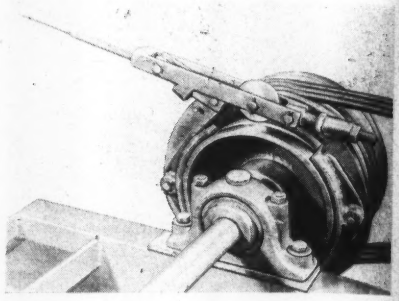
Properties: Moisture absorption, 0.38% (24 hours); tensile strength, 19,500 psi (main direction), 14,500 psi (cross direction); flexural strength, 23,000 psi (main direction, 18,000 psi (cross direction); dielectric strength (perpendicular to laminations), 725 volts per mil, short time; punches readily into intricate shapes

Applications: Radio, television and electronic equipment parts.

For more data circle MD 18, Page 191

Reduction Pulley 20

Hart Reduction Pulley Co., Milwaukee 3, Wis.



Style: Pulley with built-in clutch and overload release; V-belt or chain drive; double clutch for low and high speed or forward and reverse

Size: 4000 and 6000 lb-in. torques; larger and smaller to be available

Service: Internal pulley reduction 2½:1 to 100:1; total reduction including V-belt or chain motor to pulley drive, to 400:1

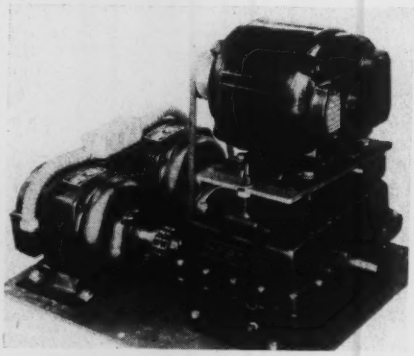
Design: Interlocking clutch control; cam and roller overload release

Applications: Machine drives with speeds below standard motors.

For more data circle MD 20, Page 191

Variable-Speed Drive 17

Speed Control Corp., 1450 E. 298 St., Dept. C-19, Wickliffe, O.



Designation: Specon OOED

Style: Motor-generator-differential, nonreversible and reversible

Size: Nonreversing, ½ hp; reversing, 1/3 hp

Service: Nonreversing output −0 min 250 to 1000 rpm max; reversing—±150 to ±600 rpm; direct coupling; max torque at zero speed

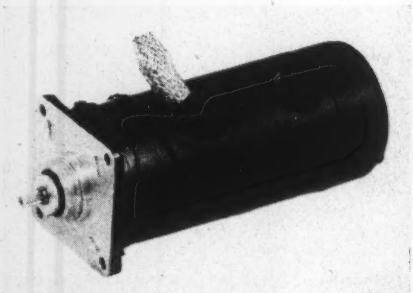
Design: Standard a-c motor coupled to two d-c motors through differential gear box; d-c motors connected in closed loop, require no outside source; all reversing action occurs in differential, motors nonreversing

Applications: For machine drives requiring increased torque at low speeds.

For more data circle MD 17, Page 191

High-Speed Motor 19

Lear, Inc., 110 Ionia Ave. NW, Grand Rapids, Mich.



Style: Model BC-05C-1

Size: 1/50-hp; 1.87 x 1.57 x 3.66 in. long; weight, 0.82 lb

Service: Duty cycle, 3 min. on, 17 min. off; 15,000 rpm; starting torque, 400% full-load torque; 26 v d-c; ambient temperature range, −65 to 165F

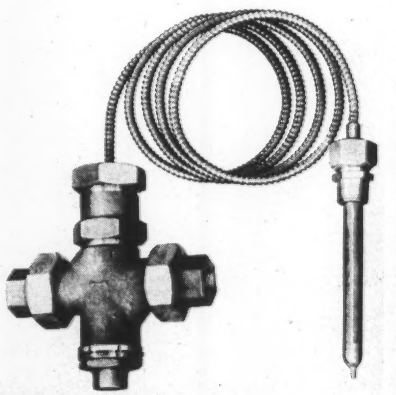
Design: Precision built for severe duty; corrosion resistant; optional features—clutch for positioning of friction load devices, electromagnetic brake for positioning control in applications which require locking or impose large load inertias on motor, thermal protector for maximum stress or overload conditions, radio noise filter to meet ANM-40 specs

Applications: High-speed precision control drive for aircraft and industrial equipment.

For more data circle MD 19, Page 191

Control Valve 21

Sterling Inc., 3738 N. Holton St., Milwaukee 12, Wis.



Designation: Sterlco

Style: Series 150E; direct-acting for heating (valve closes as bulb temperature rises), reverse-acting (valve opens as bulb temperature rises)

Size: ½, ¾ and 1-in. pipe ports

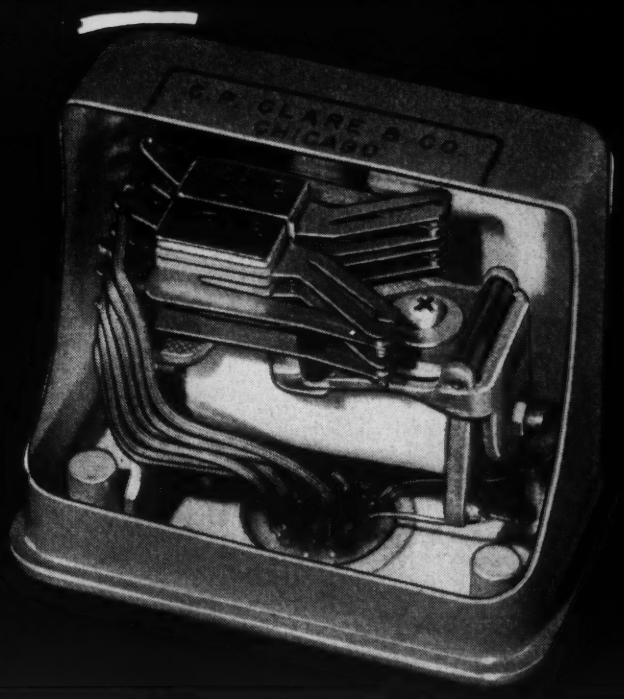
Service: Water, oil, steam or other fluids; 125 psi max pressure; constant temperature control adjustable over wide range; flow automatically modulated

Design: Bellows-packed valve, stainless steel trim and monel bellows; capillary tube; thermostat bulb; mounts any position

Applications: For automatic control of fluid heating or cooling circuits on machines or equipment utilizing heat exchangers.

For more data circle MD 21, Page 191

CLARE RELAYS



Here Is What CLARE Hermetic Sealing Means:

After assembly in the container, the enclosure is attached to a high vacuum pump and pumped down to a few microns pressure to remove all traces of moisture and gases.

While under this extreme vacuum, the enclosure and seals are tested for leaks by means of a Mass Spectrometer—a device so sensitive that it can detect a leak so tiny that more than thirty-one years would be required for one cubic centimeter of air to pass through it. This highly refined method of leak testing causes rejection of many enclosures which could pass the usual immersion tests without detection.

For most applications, the enclosure is then filled with dry nitrogen, which has a relatively high arcing potential.

Write for CLARE Bulletin No. 114

CLARE Hermetically Sealed Relays Protect Against These Conditions:

- Moisture, High Humidity and Ice
- Salt Air and Spray
- Fungus Growth
- Varying Air Pressure
- Variation of Air Density
- Dust and Dirt
- Corrosive Fumes
- Explosive Atmospheres
- Tampering

Clare Hermetically Sealed Relays are *air-tight* so that no gas or spirit can enter or escape.

This ideal condition, now available to every user of CLARE hermetically sealed relays, is the result of many years of painstaking research by the CLARE organization to produce a perfectly sealed relay at a reasonable cost to industrial relay buyers.

Hermetically sealed in an ideal atmosphere of dry inert gas, they are permanently immune to the difficult climatic and environmental conditions responsible for 95% of the failures of exposed electrical apparatus.

CLARE has today—or can provide you with—the hermetically sealed relay that you require. Over forty different series of CLARE hermetically sealed relays are described in Bulletin No. 114. Within each series, innumerable variations of coil and contact specifications are possible. Numerous other special sealed-relay units are also available.

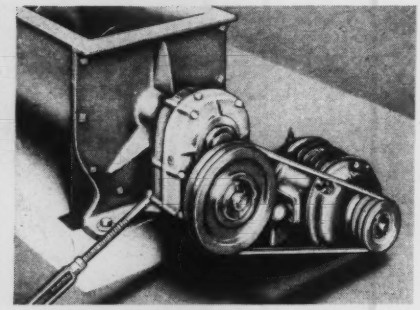
Clare sales engineers are located in principal cities to assist you in the selection of just the right relay for your specific requirement. Look them up in your telephone directory or write: C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

CLARE RELAYS

NEW PARTS AND MATERIALS

Speed Reducer 22

Dodge Mfg. Corp., Mishawaka, Ind.



Style: Shaft-mounted; V- or flat-belt drive; single reduction

Size: Four sizes to 27 hp

Service: Output, 115 to 330 rpm

Design: Secured to shaft with steel locking collars; anchored with torque arm; belt adjustment by turnbuckle; interchangeable shaft-keyed adapter bushings; machined cast-iron housing; deep-groove ball bearings; heat-treated helical gears, shaved; positive backstop to prevent load direction reversal

Applications: Reduction drive speeds for machines.

For more data circle MD 22, Page 191

Lightweight Belt 24

Baldwin Belting Inc., 74-76 Murray St., New York 7, N. Y.

Designation: Supertex

Style: Endless, 3-ply, 5-ply, brown or white

Size: Thickness — 3-ply 7/64-in. (white), 5/64-in. (brown)—5-ply 11/64-in. (white), 9/64-in. (brown); any width to 48 in.; duck weight, 9 oz.

Service: Oil and waterproof; acid and alkali resistant; nontoxic; loading per in. width 48 lb (3-ply), 80 lb (5-ply); minimum pulley diameters 1 in. (3-ply), 1½ in. (5-ply); tensile strength per in. width 420 lb (3-ply), 700 lb (5-ply); stretch at rated capacity, 1%; max temperature, 250F; friction between plies, 12-17 lb.

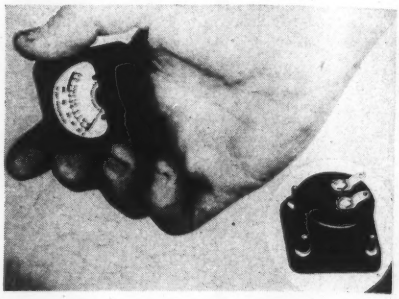
Design: Lightweight duck with neoprene rubber between all plies; raw edge construction; spliced with multiple step lap; smooth neoprene cover

Applications: For light conveying and power transmission machinery; especially suitable for food processing equipment.

For more data circle MD 24, Page 191

Audio Signal Meter 26

International Instruments Inc., New Haven 11, Conn.



Style: VU and Db; square, round and round flange mounting cases, all waterproof

Size: 1½-in. case; scale, 1.3-in. arc

Service: Specification JAN-I-6; dielectric strength, 1500v

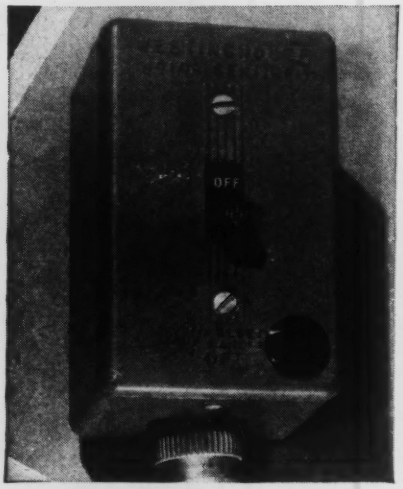
Design: D'Arsonval type; self-contained subminiature movement; scales are black on white or in reverse; round case with O-ring seal, round flange with commercial seal for panel mounting

Applications: For measuring strength of audio signals in radio TV and communication systems and armed services equipment.

For more data circle MD 26, Page 191

Motor Starter 23

Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.



Designation: Motor Sentinel

Style: Class 10-023, double-pole, manual

Size: 1 hp, max; NEMA type I enclosure

Service: 250 v a-c, or d-c

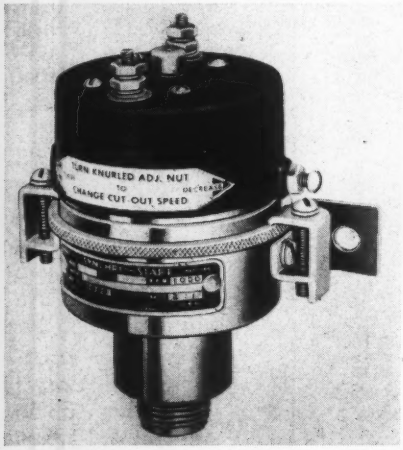
Design: Bonderized die-cast aluminum; straight-through wiring, front terminals; over-center self-indicating toggle; positive bimetallic overload protection; indicating light

Applications: Starting and protecting small a-c and d-c motors used with fans, pumps, washing machines, compressors, etc.

For more data circle MD 23, Page 191

Overspeed Governor 25

Synchro-Start Products Inc., 1046 West Fullerton Ave., Chicago 14, Ill.



Style: Model GFA (automatic reset); model GFM (manual reset)

Size: Height, 5 in.; weight, 3 lb

Service: Adjustable control of internal-combustion engines

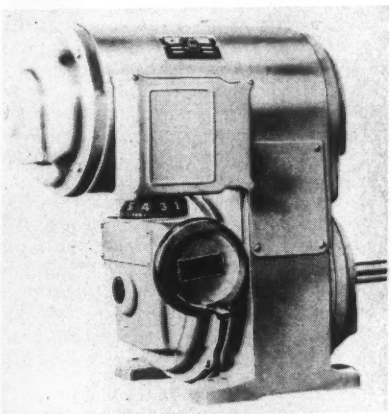
Design: All-metal construction with mounting bracket; sealed ball bearings; standard take-off for heavy-duty tachometer drive for use with a flexible shaft; can be adjusted while operating

Applications: Governing speed of internal-combustion engines and associated driven machines.

For more data circle MD 25, Page 191

Adjustable-Speed Drive 27

Sterling Electric Motors Inc., Los Angeles 22, Calif.



Style: Single-phase, capacitor type

Size: ½ to 3 hp; standard NEMA mounting dimensions

Service: Infinite speed variation within the ratios, 2:1, 3:1 or 4:1; 18 different max speeds from 2000 to 52 rpm; speed does not vary under fluctuating load conditions

Design: Fingertip speed control; one-piece cast-iron dripproof frame; "herringbone" design rotor; vinol-acetal insulated wire stator windings; new starting relay which eliminates centrifugal switches or rotary devices such as throw-out switches, commutators, brushes, etc.

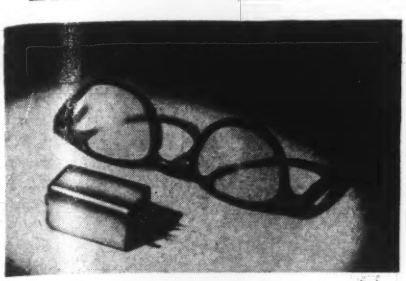
Applications: General machine drives requiring variable range of speeds.

For more data circle MD 27, Page 191

NEW PARTS

Miniature Relay 28

Sigma Instruments Inc., Boston 21, Mass.



Style: Hermetically sealed; any combination to DPDT

Size: 1 in. sq. by 1¾ in. high, exclusive of terminals

Service: DP unit—sensitivity, 40 mw, withstands 10 *g* vibrations at frequencies in excess of 60 cps; 2 to 1 margins for 'operate' and 'release' current permits sustained accelerations to 50 *g*

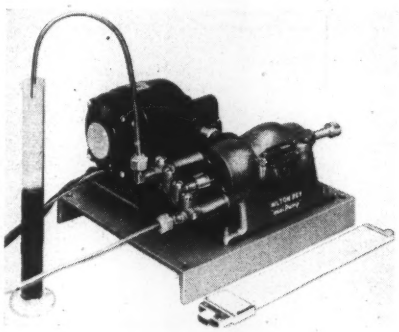
Design: Switch coupled to armature to eliminate wear effect on pull-on and drop-out points

Applications: Electrical machine relay control circuits.

For more data circle MD 28, Page 191

Metering Pump 29

Milton Roy Co., Philadelphia 18, Pa.



Style: Positive displacement reciprocating plunger, simplex, duplex and multiplex models

Size: Plunger, ⅛-in. diameter; valve, ⅝-in. width, 3-in. overall length; check balls, 3/16-inch

Service: Clear fluids such as perfumes, odorants, dyes, vitamins, antifreeze, etc.; 3 cc to 800 cc per hour; operating pressures to 1000 psi; accuracy, 99+%

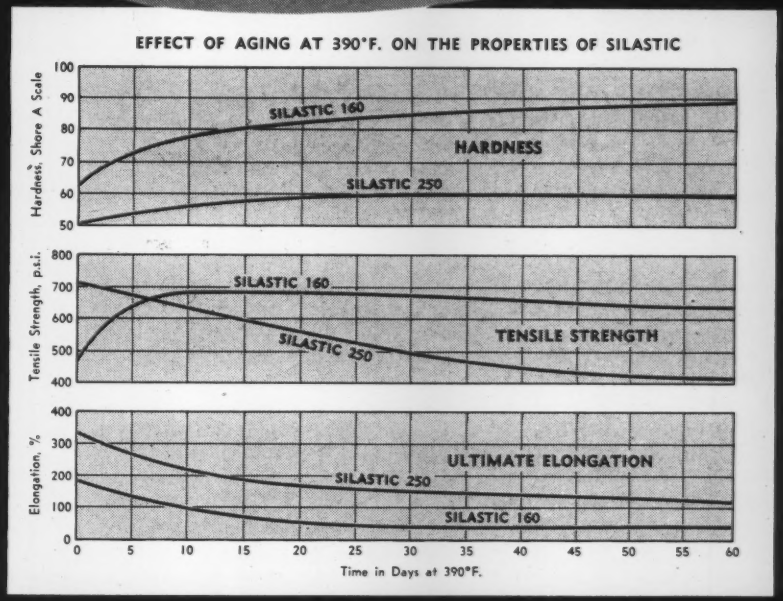
Design: Powered by fractional gearhead motor; plungers cam-actuated; stroke adjustable from zero to capacity; double ball-check delivery; bearings, self-lubricated; liquid end and plunger, Carpenter 20 stainless steel; ball checks, 440 stainless steel, glass or synthetic sapphire

Applications: Accurate metering in laboratory and research work, pilot plant and small-scale operations.

For more data circle MD 29, Page 191

Long after organic rubber melts or becomes brittle...

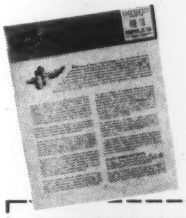
SILASTIC* *still* stays Elastic!



We're talking about an elastomer that retains its rubbery properties at temperatures far above and far below the limits of any other elastic material. That is indicated by the effects of accelerated aging at 350°F. on the properties of two typical Silastic stocks with brittle points in the range of −70° to −130°F.

Silastic is being widely used at temperatures in the range of 250° to 600°F. and at temperatures ranging from −75° to below −100°F. It shouldn't be called a rubber because that term invites comparisons that are not valid. At room temperatures, the physical properties and abrasion resistance of Silastic are well below the values normally associated with rubber. Conversely, at temperatures well within the serviceable limits of Silastic, rubber rapidly becomes a soft gum or a brittle solid.

The important thing about Silastic is that it retains its physical, chemical and dielectric properties over a temperature span of about 600 Fahrenheit degrees. When you need rubbery properties or good dielectric properties in a resilient and flexible material at temperatures beyond the limits of ordinary rubber, investigate Silastic.



***SEND TODAY!** for your copy of Silastic Facts No. 10 containing new data on the properties, performances and applications for all Silastic stocks.*

*T. M. REG. U. S. PAT. OFF.

from +500°F. **SILASTIC** stays Elastic to −100°F.

DOW CORNING CORPORATION. DEPT. P-24, MIDLAND, MICH.

Please send me Silastic Facts No. 10

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

Dow Corning

FIRST IN SILICONES

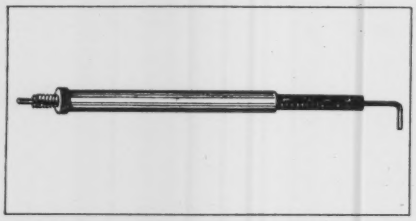
Atlanta • Chicago • Cleveland • Dallas • Los Angeles • New York • Washington, D. C.
In Canada: Fiberglas Canada Ltd., Toronto • In Great Britain: Midland Silicones, Ltd.

ENGINEERING DEPARTMENT

EQUIPMENT

Tension Tester 30

All-Weather Springs, New York, N. Y.



Styles: Push-pull terminals; alligator clamp; insulated thong

Service: 12 oz to 12 lb

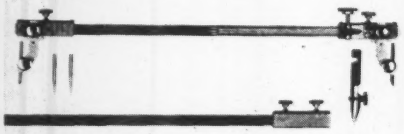
Design: Simple, compact tubular design, direct reading scale

Applications: Testing tensions or pressures in instruments, etc., in field or factory; insulated thong style for brush tension testing.

For more data circle MD 30, Page 191

Beam Compass 32

V & E Mfg. Co., Pasadena 20, Calif.



Style: Rectangular beam

Service: Large-scale pen, pencil or divider drafting; radii, 8¼ to 12 in.; special extensions for radii to 6 ft; 4-in. rack for slow-motion micrometer adjustment

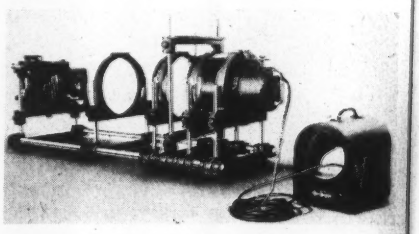
Design: Beam — ¼-in. hard-rolled structural aluminum alloy; legs—chrome plated cold-rolled steel, detachable from slide and interchangeable, extend one inch below beam; holders—steel points, split clamp and screw type; sliders and coupler—chrome plated cold-rolled steel; clamp screws — stainless steels

Applications: Precision inking, scribing on tool steel and other metals, heavy-duty all-pencil drafting, etc.

For more data circle MD 32, Page 191

Polariscope 34

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.



Style: Type 1534-A; horizontal

Size: 36 x 14¼ x 16½ in.; 32 lb

Service: 8-in. field; 0.00004-second exposure; horizontally adjustable and vertically adjustable over nine inches; camera aperture f/4.5

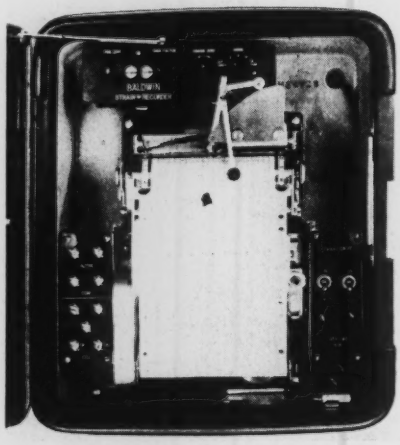
Design: High-speed, high-power stroboscopic lamp; diffuser; polarizer; straining bridge; analyzer; filter camera; degree scale for isoclinic determination.

Applications: For viewing and photographing stress patterns in plastic models by polarized light.

For more data circle MD 34, Page 191

Strain Recorder 31

The Baldwin Locomotive Works, Philadelphia 42, Pa.



Style: Electronic, single strip-chart

Size: Ranges 0-2000, 0-5000 and 0-10,000 microinches per inch

Service: For SR-4 strain gages, 120 1.2 ohms resistance, 1.9 and 2.2 sensitivity factor; ten chart speeds, ¾ to 720 in. per hour

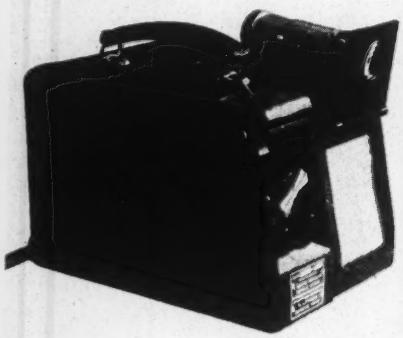
Design: One gage active and other for temperature compensation or both gages active for combined bending-tensile stress or strain

Applications: Continuous measurement of surface strain.

For more data circle MD 31, Page 191

Oscillograph 33

Sound Apparatus Co., Stirling, N. J.



Style: Straight-line, rectangular coordinates (not curved)

Size: 10 x 8 x 7 in., 13 lb

Service: Frequency range, 0 to 600 cycles; measuring range, 5 to 160v; max amplitude, 2 x 30 = 60 mm; sensitivity, 0.1 mm/v; impedance, 2700 ohms

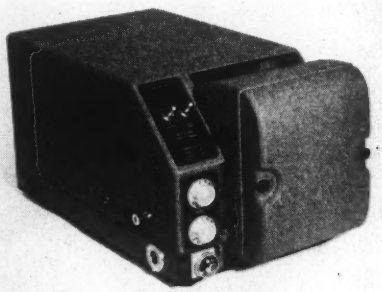
Design: Ten selectable paper speeds; pen closes automatically when instrument not in use; record on transparent paper which can be projected and reproduced

Applications: For recording electrical oscillations.

For more data circle MD 33, Page 191

Oscillograph 35

Consolidated Engineering Corp., Pasadena 4, Calif.



Style: Type 5-116 electronic; optional transmissions, mounts, traces

Size: Length 19½ in., width 9½ in., height 9 in., weight 42½ lb; 125 ft of 5-in. recording material

Service: Trace block capacity, 9 or 14; record speeds, ¼ to 100 in./sec; writing speeds, 25,000 in./sec (standard), 50,000 in./sec (optional); 0.1 and 0.01-second timing lines; power, 24 to 28 v d-c or 115 v 60-cycle a-c

Design: Change gear transmission, ten-speed quick-change gearshift optional; automatic record numbering, one counter for both viewing and recording; series 7-200 galvanometers

Applications: For measuring electrical oscillations.

For more data circle MD 35, Page 191

The KAYDON *technique of deep-flame-hardening for bearings of unusual shapes, sizes and thin sections*

Designers and users of special machinery will appreciate this information on **KAYDON**-pioneered deep-flame-hardening which has helped remove bearing-limitations that heretofore proved to be serious handicaps.

This new **KAYDON** technique in deep-flame-hardening hardens only the raceways of the bearings. This permits the races themselves to be accurately drilled, tapped and gear-cut . . . eliminates many of the surrounding parts which normally would be necessary . . . results in important weight-reduction . . . makes possible the creation of unusual designs that accommodate minimum sizes of bearings in the space available . . . permits unusual shapes, very large diameters, and extremely thin sections, all of which greatly facilitate mounting.

Write for this Bulletin on **KAYDON** Deep-Flame-Hardening . . . and when you need the unique services offered, contact **KAYDON** of Muskegon.

KAYDON Types of Standard or Special Bearings: Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust

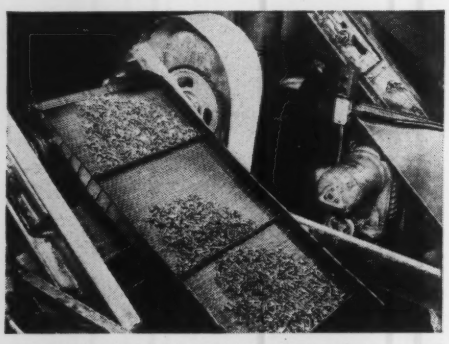
THE KAYDON ENGINEERING CORP., MUSKEGON, MICH.

• ALL TYPES OF BALL AND ROLLER BEARINGS 4" BORE TO 120" OUTSIDE DIAMETER •

Your Cambridge woven wire conveyor belt is engineered from the raw materials to the finished belt to give you maximum efficiency with a minimum of attention and maintenance.

Cambridge designs withstand heavy loads, high temperatures, cold, corrosive compounds or wet processes. They may be fabricated of any metal or alloy in any mesh and weave. Where necessary, Cambridge belts can be fitted with various types of selvages, cleats and drives.

Call your Cambridge Field Engineer whenever you have a problem concerning movement of materials during processing.



A Cambridge Rod-Reinforced Belt with Plate Selvages and Fabric Cleats provides cost-cutting continuous quenching of screws, nuts and bolts. This belt design offers the highest tensile strength, low thermal capacity and successful operations in temperatures as high as 2100° F.

VALUABLE BOOK, FREE! A complete, basic reference on conveyor belts, designs, systems and metallurgy. Write for your copy or call your nearest Cambridge office.

Cambridge Wire Cloth Co.

Wire cloth in rolls. | Also specialized wire fabrications

Department N
Cambridge 12, Md.

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

See "Belting, Mechanical" in your Classified Telephone Directory.

MEN OF MACHINES

C. E. Willis

Lear Inc. announces the appointment of **C. E. Willis** as chief engineer. A mechanical engineer, Mr. Willis was previously associated with the Fairchild Engine and Airplane Corp. as staff engineer, during which time he did extensive work relating to aircraft heating and ventilating problems and aircraft power plants. He is a former chief engineer and general manager of Aero Engineering Inc., and a former project engineer for Curtis Wright where he worked on the development of the XSC-1 and C-46 aircraft. In his new capacity Mr. Willis will be applying at the design level the benefits of his extensive experience in solving aircraft accessory equipment problems.

♦

W. R. Spiller

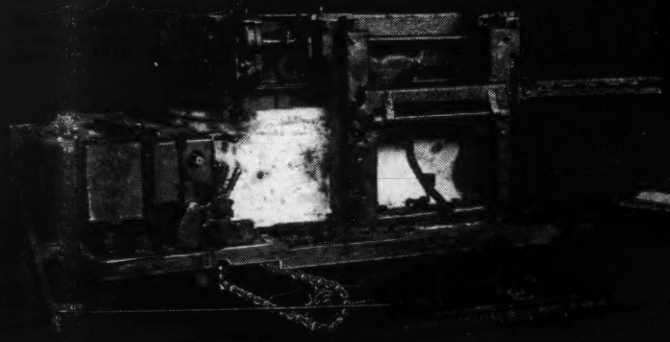
W. R. Spiller, assistant vice president of the Harris-Seybold Co., has been appointed chief engineer. Mr. Spiller has been associated with the design of heavy machinery for twenty-eight years—the last twelve being with the Harris-Seybold Co. He is an engineering graduate of the University of Pennsylvania and holds thirty patents.

♦

Charles D. Perrine Jr., specialist in missile homing guidance systems, has joined the electronics and guidance section in Consolidated Vultee's San Diego Divi-

1905

1916



1933

THROUGHOUT NEARLY A HALF CENTURY

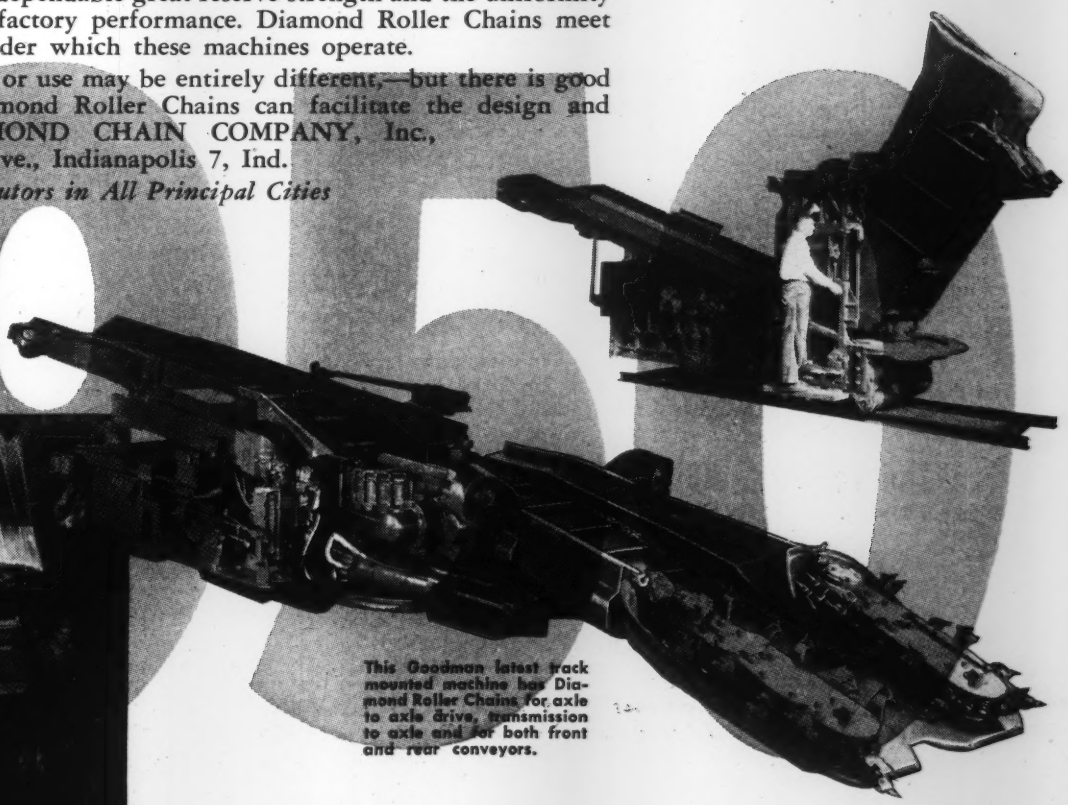
Powerful Goodman Machines Have Been Equipped With DIAMOND Roller Chains

• Pioneer builder of rugged, fast production mining machinery, Goodman has had nearly a half century experience with Diamond Roller Chain Drives.

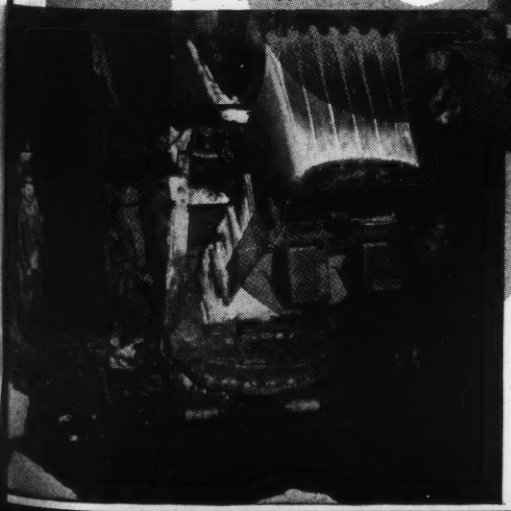
For such tough work, the dependable great reserve strength and the uniformity of quality are vital to satisfactory performance. Diamond Roller Chains meet all the severe conditions under which these machines operate.

The machinery you build or use may be entirely different,—but there is good reason to believe that Diamond Roller Chains can facilitate the design and improve operation. DIAMOND CHAIN COMPANY, Inc., Dept. 435, 402 Kentucky Ave., Indianapolis 7, Ind.

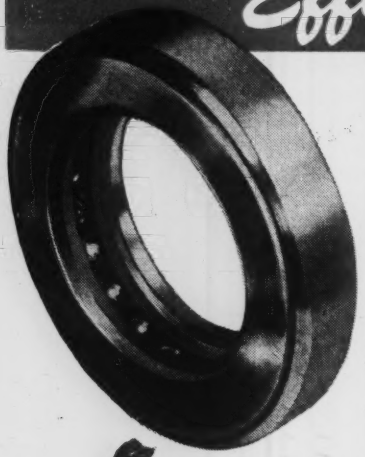
Offices and Distributors in All Principal Cities



This Goodman latest track mounted machine has Diamond Roller Chains for axle to axle drive, transmission to axle and for both front and rear conveyors.



And on Goodman "Conway" Shovels that have established records in muck handling in tunnels, and in coal and metal mines, Diamond Roller Chains for drives and conveyor operation are regularly supplied.



All industry knows Yale Lift Trucks as rugged workers that cut costs, speed production, handle all kinds of materials in volume—faster, safer, more efficiently.

Important contributors to their efficiency are the rugged ball thrust bearings in the trailing axle and wheel assembly—bearings specially designed to

meet the high load capacity, precision smoothness and long, trouble-free performance required in this tough application—bearings which Aetna has proudly supplied for over 15 years.

Improved performance, longer life and minimized maintenance are advantages which come to any hard working equipment when Aetna bearings lend a hand. Our engineers are ready and willing to work with you at any time.

AETNA BALL AND ROLLER BEARING COMPANY

4600 SCHUBERT AVENUE • CHICAGO 39, ILLINOIS

Aetna

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings

sion Engineering Department. Mr. Perrine will specialize on missile guidance problems and electronics.

♦

William F. Pioch has been appointed manager of manufacturing engineering of the newly formed Aircraft Engine Division of the Ford Motor Co. Mr. Pioch joined Ford in 1912 as a tool designer. In 1921 he was named assistant chief tool designer for the company and was promoted to chief tool engineer in 1926. He served in that capacity until assigned to Willow Run bomber plant as chief engineer.

♦

Joseph S. Jacoby Jr. recently joined the Capehart-Farnsworth Corp. as assistant chief engineer.

♦

A. R. Kelso has been elected vice president of Mack Trucks Inc. Mr. Kelso has been previously connected with Hudson Motor Car Co., Continental Motors Corp. and Motor Products Corp.

♦

Alex D. Matheson has been appointed general manager of French and Hecht Division, Kelsey-Hayes Wheel Co.

♦

The Falk Corp. announces the promotions of several members of its engineering department. **George P. Maurer** has been named assistant chief engineer, Gear Technology. **W. Stephen Richardson** is new assistant chief engineer, Applications and Special Products. **Edward J. Wellauer** has been appointed assistant chief engineer, Materials and Research.

♦

Dr. John T. Rettaliata, dean of engineering at Illinois Institute of Technology, becomes vice president for academic affairs.

♦

Abart Gear & Machine Co. announces the appointment of **O. W. Klima** as chief engineer. Since graduating from Armour Institute of Technology, Mr. Klima has specialized in power transmission equipment and machine design.

♦

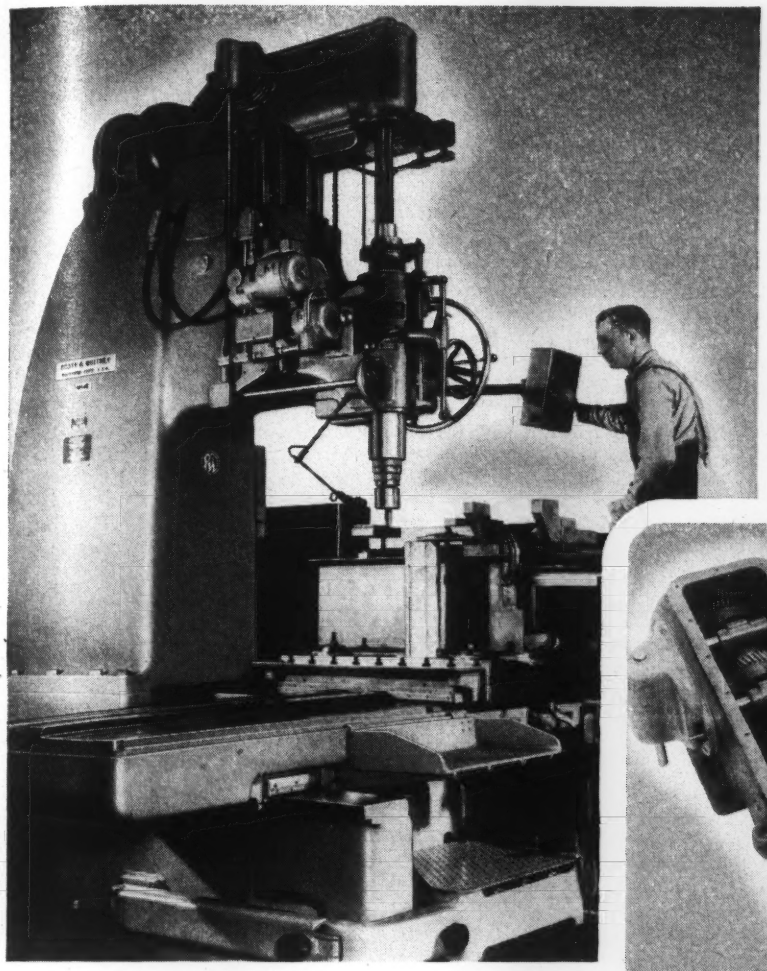
Westinghouse Electric Corp. has announced the appointment of **Carl F. Herbold** as director of manufacturing planning.

♦

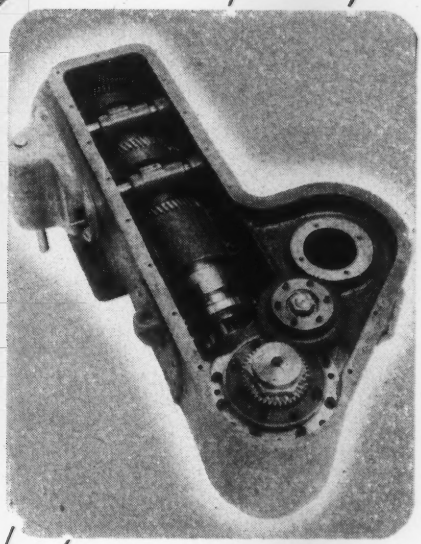
Edward F. Doty has joined the Warren Steam Pump Co. Mr. Doty was formerly with Quimby Pump Co. specializing in design and application engineering. He was the originator and developer of the modern method of computing screw capacities, friction and slippage losses in Screw and Rotex pumps.

♦

Harold Wolchonok, head of Sightmaster's television engineering department and responsible for all new Sightmaster developments during the past several years, has been engaged by Transvision Inc. to head up their research television engineering. In addition to his new duties, Mr. Wolchonok will continue on



15 TONS OF *Accuracy!*



Pratt & Whitney Model 4E Jig Borer.

Inset: View of Twin Disc MTU Duplex Clutch in the gearhead.

. . . with a Twin Disc Clutch

It takes real *precision* to locate and bore holes with an accuracy of *.0002"*. But Pratt & Whitney's new Model 4E Jig Borer does it. A 15-ton example of accuracy, stability and fine workmanship, this machine utilizes a 4½" Twin Disc MTU Duplex Clutch and brake combination in the gearhead.

Built to "wear like a bearing and perform like the best friction clutch" . . . that's the standard to which Twin Disc machine tool clutches are held. In addition to compactness, high torque capacity and long wear-life, Twin Disc Clutches feature ease of operation and single point adjustment. No wonder precision manufacturers like Pratt & Whitney think of Twin Disc when their design calls for *accuracy.*

For more information on Twin Disc Machine Tool Clutches see your nearest Twin Disc dealer or write for Bulletin No. 134-A.

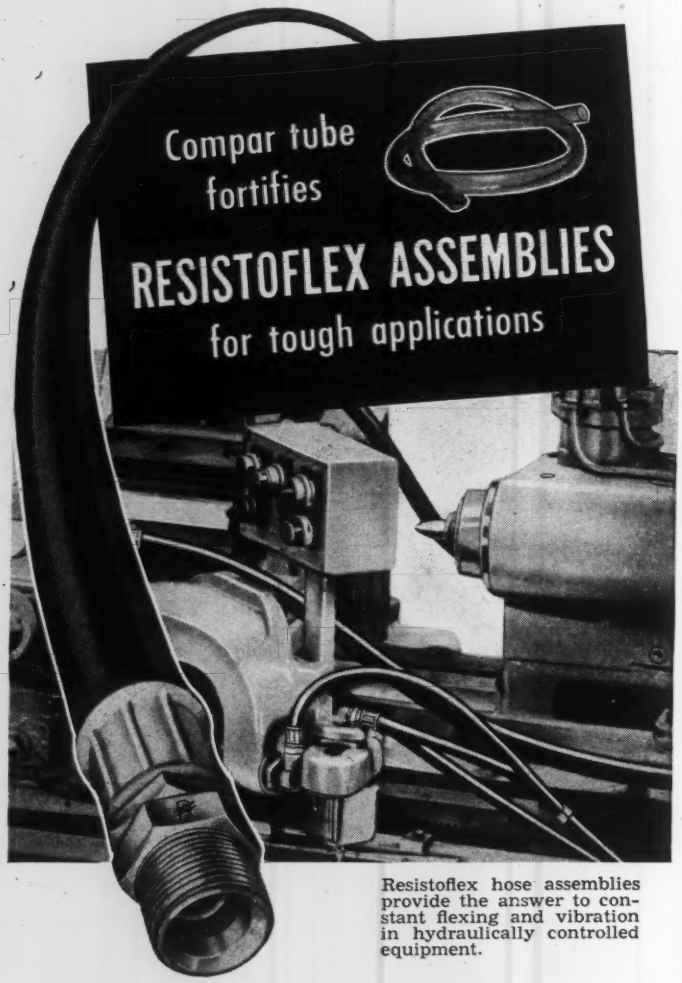
TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

Clutches & Hydraulic Drives

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

Extra Strength in this Oilproof Hose!



Resistoflex hose assemblies provide the answer to constant flexing and vibration in hydraulically controlled equipment.

THREE REASONS explain why more and more manufacturers standardize on Resistoflex Hose Assemblies. These lines, containing no metal reinforcements, have: (1) Superior flexibility and are fatigue-proof. (2) High burst strength for medium as well as low pressure installations. (3) Complete impermeability to oils. All these advantages, of course, add up to fewer service troubles and replacements.

The extra durability of Resistoflex hose is assured by its unique construction. It has the compar tube. This high tensile tube not only reinforces the hose against shock loads, but also helps maintain clean systems because it doesn't swell, gum or erode in contact with oils.

If you have an application involving flow of hydraulic, lubricating or water-insoluble cutting oils, it will pay you to learn more about these light, cost-cutting, compar-tubed lines. Other assemblies available for gases, refrigerants or tough solvents. Write us about your problem, or for more information.

Trade-Mark Reg. in U.S. & Can. Pat Off.
TRADE RESISTOFLEX MARK

RESISTOFLEX
CORPORATION

Belleville 9, New Jersey

SYNTHETIC FLEXIBLE PRODUCTS AND PARTS FOR INDUSTRY

as Sightmaster's chief consultant and television department engineer.

♦

L. R. Ludwig has been appointed assistant to the vice president of industrial products of the Westinghouse Electric Corp.

♦

Macon Fry, Ordnance Consultant, formerly of Harrington Park, N. J., is now located in Alexandria, Va.

♦

Lyman W. Orr, George W. Patterson and **Donald L. Stevens** have joined the staff of Burroughs Adding Machine Co.'s Research Division in Philadelphia, Pa. **Alex J. Bielski** has joined the staff of the Research Division of the Burroughs Adding Machine Co. in Detroit. **Perry C. Smith** and **Thomas H. Briggs** have joined the Research Division of the Burroughs Adding Machine Co. as supervisor of the special devices department and research engineer in the special devices dept. respectively.

♦

Recently announced was the election of **Raymond R. Rausch** as vice president and executive assistant to the president of Willys-Overland Motors Inc.

♦

Lyman H. Allen Jr., formerly assistant chief design engineer in charge of chemical process design with the American Viscose Corp., has been appointed chief engineer of Foster D. Snell Inc. Mr. Allen will be in charge of supervising the design and construction of spray dryers, pilot plant operations, etc.

♦

Bernard W. Shaffer has been appointed assistant professor of mechanical engineering at the New York University College of Engineering.

♦

Malvern J. Gross, formerly vice president of the General Electric X-Ray Corporation, in charge of engineering, has been appointed administrative assistant to Dr. Kenneth H. Kingdon, technical manager of the Knolls Atomic Power Laboratory.

♦

R. H. Weigel has joined National Radiator Co., Johnstown, Pa., as a senior research engineer.

♦

Fred K. Knohl has been appointed chief engineer of Shakeproof Inc. Mr. Knohl was formerly in charge of field engineering. In his new duties he will supervise all design modifications of standard fastener products, special stampings and screw products.

♦

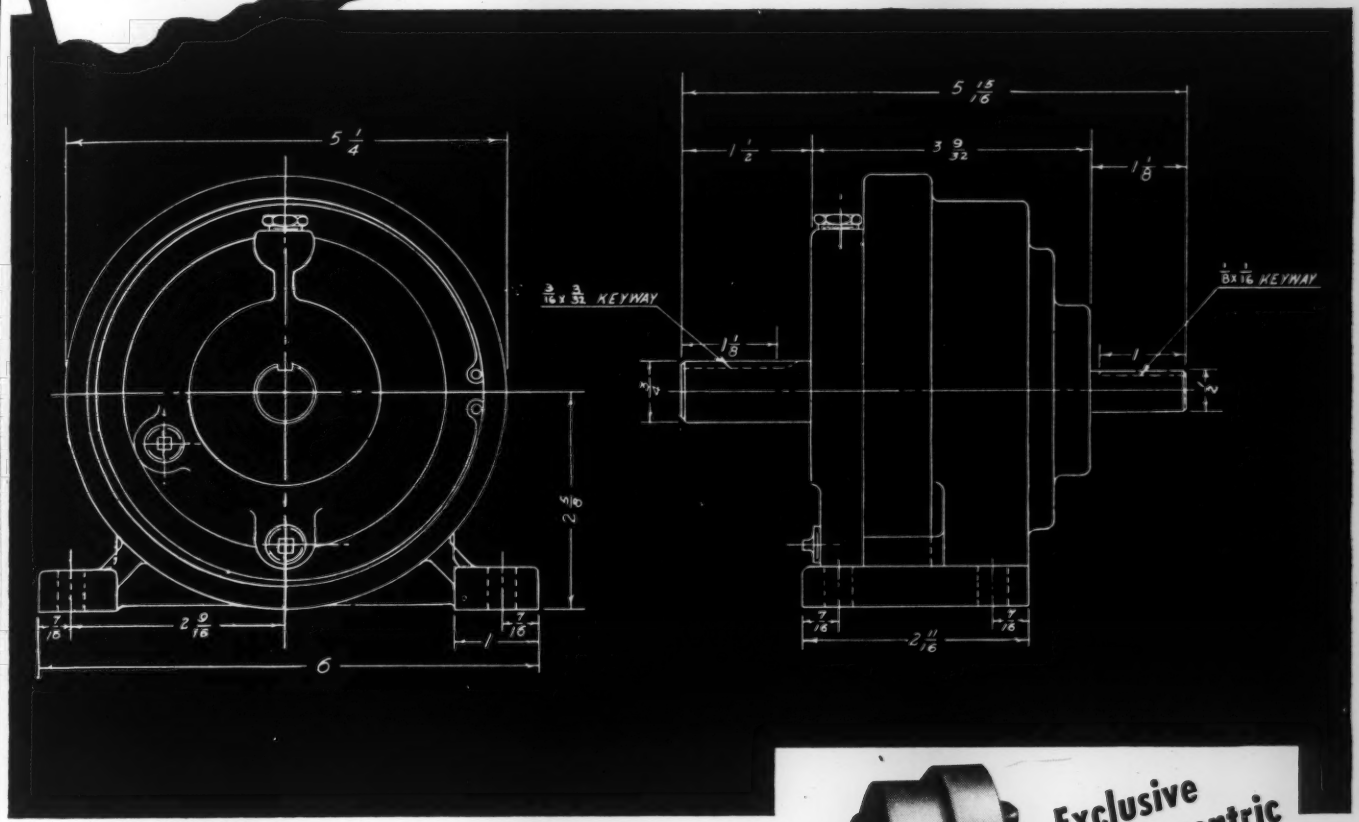
William H. Chapman has been appointed director of engineering to co-ordinate machine and product design, research and application engineering of the Hyatt Bearings Division of General Motors Corp.

♦

The American Gear Manufacturers Association has awarded the Edward P. Connell Award for 1950 to **Earle Buckingham.**

Memo to MACHINE DESIGN READERS:

Save SPACE and COST by using this *New* Universal Speed Reducer in your design



Ratios available up to 1,000,000 to 1 for all in-line reducer requirements . . . 80 to 1 in single-stage units from ¼ to 1 horsepower

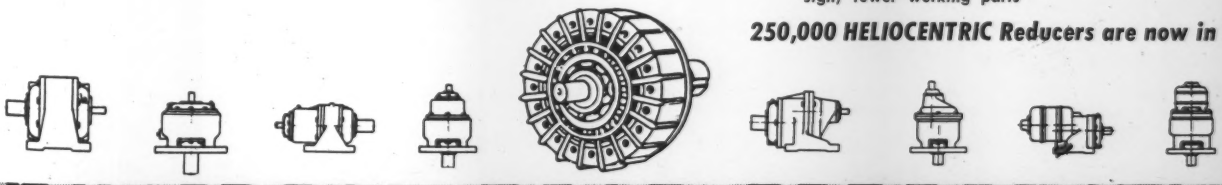
The HELIOCENTRIC principle of speed reduction is employed in the new Model 5E reducer which is not only available in the Strateline design but also in motorized and right-angle types to meet every design requirement.

Write today for complete information on these new Universal Gear HELIOCENTRIC Speed Reducers.

Check these specifications of Universal's new Model 5-E Heliocentric Speed Reducer against your requirements for compact, quiet, low-cost speed reduction:

- Maximum torque capacity—1000 inch-pounds
- Suitable for any installation with 1800 rpm input or less
- Straight-line reduction in a streamlined package
- Anti-friction ball bearings used throughout
- High efficiency at lower cost because of simplified design, fewer working parts

250,000 HELIOCENTRIC Reducers are now in service



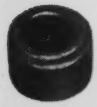
UNIVERSAL GEAR CORPORATION

Specialists in Power Transmission Equipment · Indianapolis 7, Indiana

Purebon

solves many problems

caused by sliding or rotating parts which are difficult or impossible to lubricate



A constantly increasing stream of problems are facing engineers and designers today involving sliding or rotating parts where lubrication is difficult or impossible. For such applications, Purebon, the mechanical carbon, is often the ideal answer. Typical applications are seal rings, bearings, pistons, piston rings, pump vanes, valve seats, meter discs, and a host of similar items. Purebon comes in a wide variety of grades. It is strong, tough, readily machineable and in many cases can be molded directly to size.

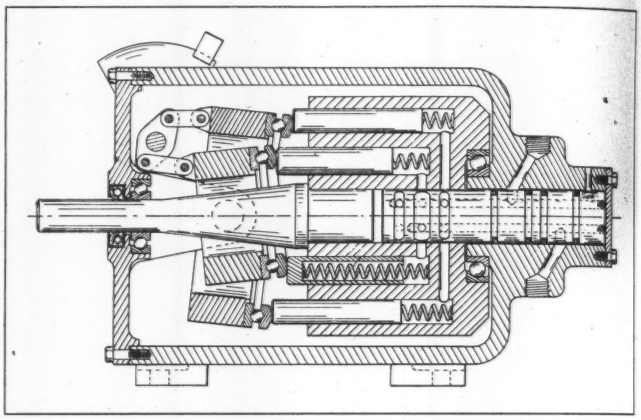
Bulletin No. 482 tells the complete story of Purebon. Write for your copy today.

PURE CARBON CO., INC.

446 HALL AVE. ST. MARYS, PA.

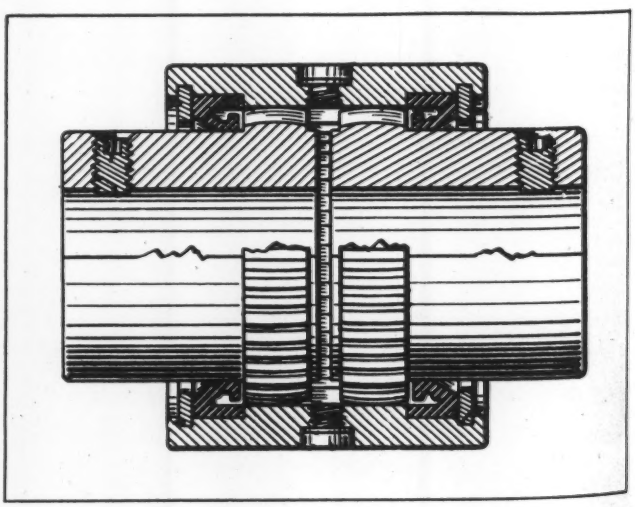
NOTEWORTHY PATENTS

BALANCED CONSTRUCTION of a swash-plate type pump or motor, using two concentric sets of axial plungers, eliminates unbalanced forces in the rotating barrel assembly. The two swash plates are 180 degrees out of phase, so that the sum of the pumping and suction forces is substantially constant

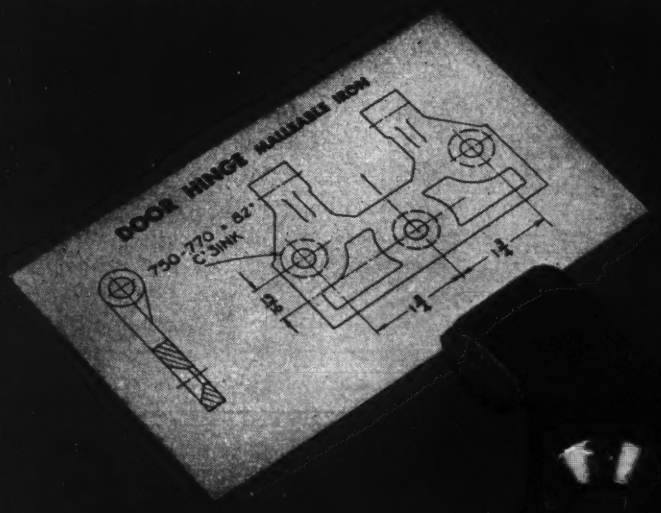


at any point around the barrel. A stationary valve, secured in the housing and projecting within the rotating barrel, is provided with drilled passages and circumferential grooves to permit continuous feeding and exhausting of the two sets of plungers. Joseph Greenhut has assigned the patent, No. 2,520,632, to The Torque Electric Manufacturing Co.

SIMPLIFIED gear type flexible coupling design, permitting straight-through broaching of the one-piece coupling sleeve instead of the usual gear cutting, is



1000 PCS. PER HOUR...



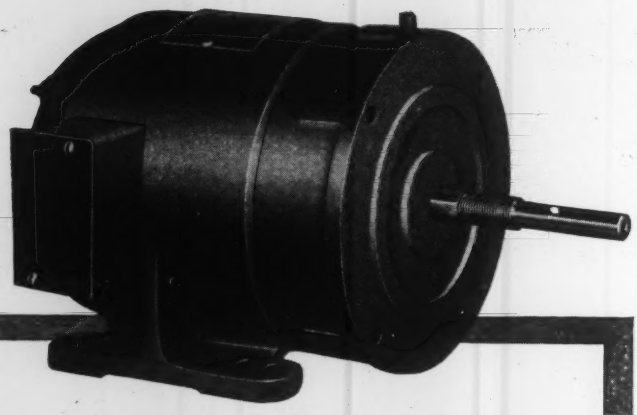
automatically fed, countersunk & ejected on this Hartford Special Automatic Drilling & Tapping Machine

Write for New Bulletin

THE HARTFORD SPECIAL MACHINERY CO.

HARTFORD 5, CONNECTICUT

HARTFORD Special



Your Peerless Electric Motor Department can serve you promptly

ONE of the finest motor engineering staffs can be your motor department when you call on Peerless Electric.

Peerless private air service—a Beechcraft Bonanza—can carry one of our sales engineers to see you on reasonably short notice, if necessary. He'll get to your problem quickly—right at your desk with your own designers—ready to work out the toughest motor problem.

Peerless Electric motor engineering, noted for dependability and versatility since 1893, is as progressive as the modern age, and now, more than ever, available as the motor department of your business.

THE PEERLESS ELECTRIC CO., WARREN, OHIO

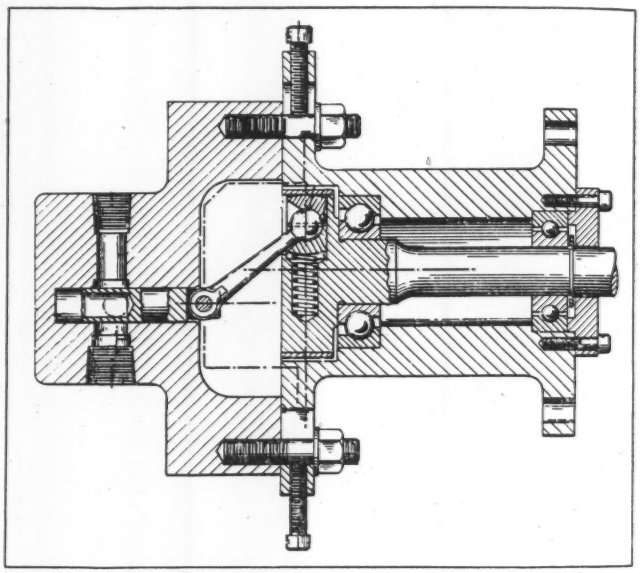
Manufacturers of Quality Motors Since 1893

Single Phase • Polyphase • Direct Current • ¼ to 15 H.P.

ALL *Peerless Motors* ARE "PEERLESS REGISTERED"

described in patent 2,510,414, assigned to Sier-Bath Gear and Pump Co. Inc. by Robert S. Philbrick. The single-piece sleeve eliminates complicated operations necessary in production and assembly of conventional two-part sleeves. Seal packing ring channels and retaining ring grooves are of larger diameter than the sleeve teeth root diameter, permitting the simpler broaching operation.

TRANSLATION OF ROTARY MOTION of a shaft-driven disk to the reciprocating pumping action of an axial plunger pump is accomplished through offset axes and a clevis and ball-and-socket mechanism as covered in patent 2,517,645. The connecting rod between plunger and disk is securely held in the disk between two spring-loaded socket members, variable reciprocating motion being imparted to the plunger

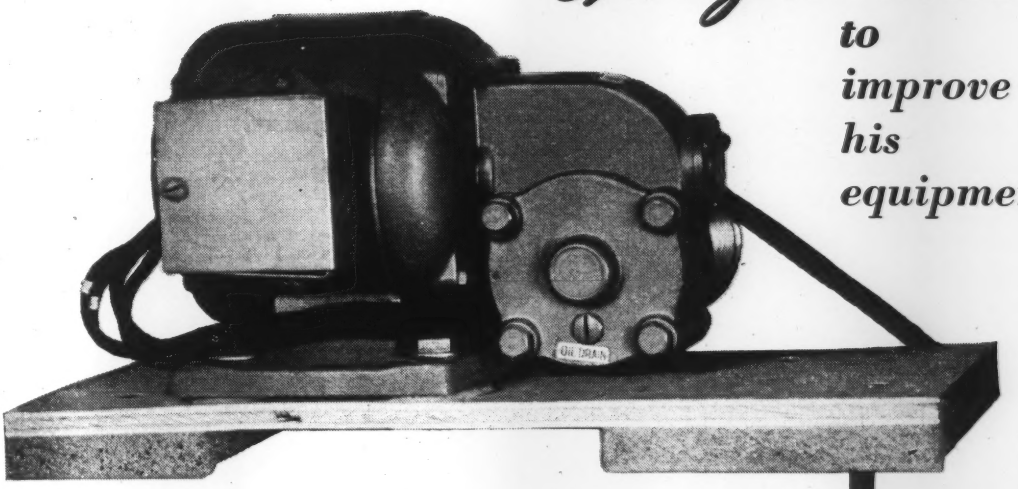


because of the offset or distance between plunger and shaft axes. A clevis joint between connecting rod and plunger causes the latter to rotate in addition to its axial movement. Grooves and porting in the plunger and its cylinder permit fluid to enter the plunger cylinder from the inlet supply line. Rotation of the plunger traps fluid in the cylinder and reciprocation of the plunger then pumps the fluid through outlet ports which open on further rotation of the plunger. Pumping capacity is adjusted by sliding the shaft housing relative to the pump body to change the offset distance between plunger and shaft axes. Carl F. Erikson has assigned the patent to Nathan Manufacturing Co.

ALIGNED OIL PASSAGES on the valve of a rotary valve type internal combustion engine provide pressure lubrication to individual bearing surfaces in controlled amounts at selected time intervals. The conical rotary valve, containing the combustion

an imaginative photographer uses

Spongex® cellular rubber *to improve his equipment*



Portable motor no longer "walks" away from its job

Jack Stock's portable motor "walked" away every time he put it to work. He mounted the motor on Spongex cellular rubber—now it stays on the job. Spongex absorbs the vibrations that give legs to portable motors.

Mr. Stock is in the commercial photography business; he doesn't manufacture motors. As a neighboring businessman in Shelton, he is well acquainted with the properties of Spongex cellular rubber. Now he mounts all his motors, stationary and portable, on Spongex.

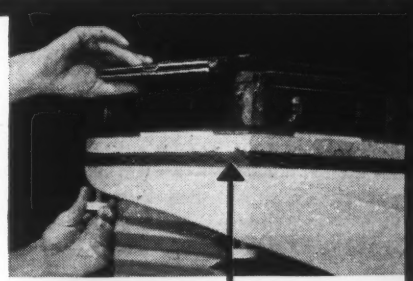
Smaller illustrations show other ways Spongex helps to produce better results in Mr. Stock's business.

If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex*. Cellular rubber does not become a "product" until you make it one in *your* application.

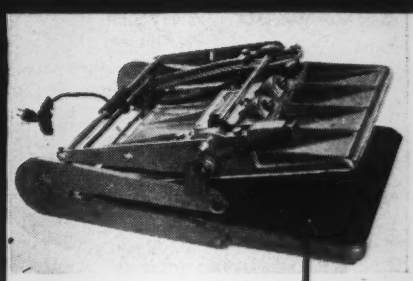
Technical Bulletin on Sponge Rubber available on request.

SRP

Uniform, dustless, printing contact
In place of felt, Mr. Stock substituted Spongex on this photograph printer. Contact on film negative is more uniform, and the tendency of felt to pick up dust is avoided.



Seal against light and dust
In installing this copy camera attachment, custom made by Mr. Stock, on top of a photograph enlarger it was essential to block out dust and light. A Spongex gasket performs perfectly.



Resilient compression pad
This dry mounting press is fitted with a resilient Spongex cellular rubber base. Spongex equalizes pressure to mount photographs evenly and more securely on their backings.

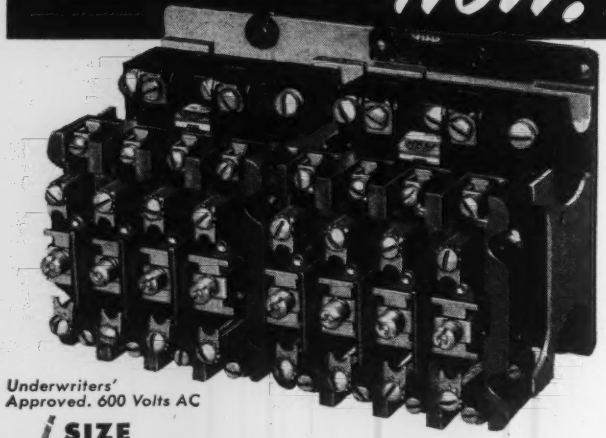
The World's largest specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY

300 Derby Place, Shelton, Conn.

✓ Check

R-B-M INDUSTRIAL CONTACTORS NOW!



Underwriters' Approved. 600 Volts AC

✓ **SIZE**

Non-Reversing

2 to 4 Pole 2-3/4″ w. x 3-5/8″ h. x 3-5/16″ d.
5 to 8 Pole 5-9/16″ w. x 3-5/8″ h. x 3-5/16″ d.

Reversing

2 to 4 Pole 5-9/16″ w. x 3-5/8″ h. x 3-5/16″ d.

Note: 10 and 15 ampere contactors have same mounting and overall dimensions.

✓ **ACCESSIBILITY**

To replace contacts, it is not necessary to disassemble the complete contactor. Just remove the parts comprising the stationary and movable contacts. Contacts can be replaced without disturbing wiring. To change coil, remove magnet frame and coil assembly only. (See illustration below.)

✓ **FLEXIBILITY**

Using a screw driver only, you can easily change any pole from normally open to normally closed. No special parts required. 10 and 15 ampere parts are interchangeable.

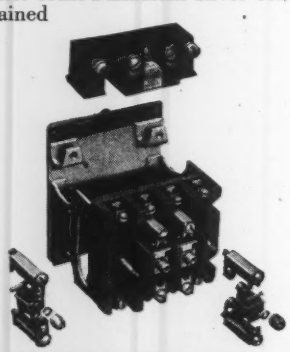
✓ **RELIABILITY**

Laboratory tests involving millions of operations, plus field service of thousands of R-B-M contactors on door operators, radio transmitters, packaging and weighing machinery, hoists, machine tools and many other industrial applications offer proof of dependable, trouble-free performance.

✓ **ADVANCED DESIGN**

Melamine Insulation. Molded coil housing. Ilsco solderless connectors. 50/60 cycle magnet coils. Palladium silver contacts. Stainless steel self-contained contact springs.

Where space is a factor, and accessibility a must—use R-B-M industrial contactors. Initial low cost plus dependable performance will save you money. Write for Bulletin 600 and price list on your company letterhead.

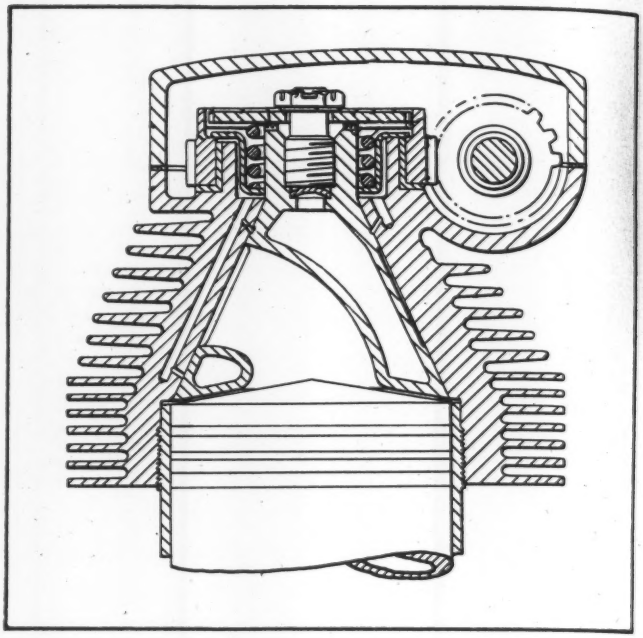


Dept. B-12, R-B-M DIVISION OF ESSEX WIRE CORP.

RBM

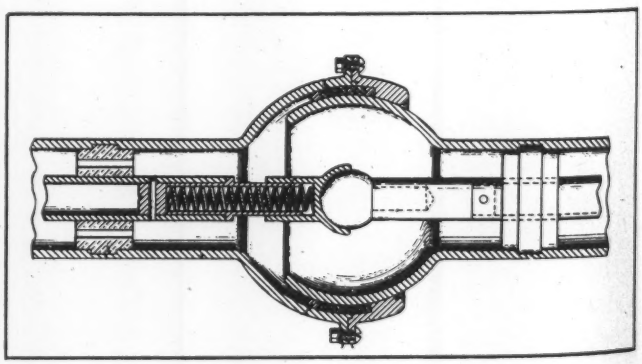
R-B-M DIVISION ESSEX WIRE CORP.
Logansport, Indiana

MANUAL AND MAGNETIC ELECTRIC CONTROLS
—FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

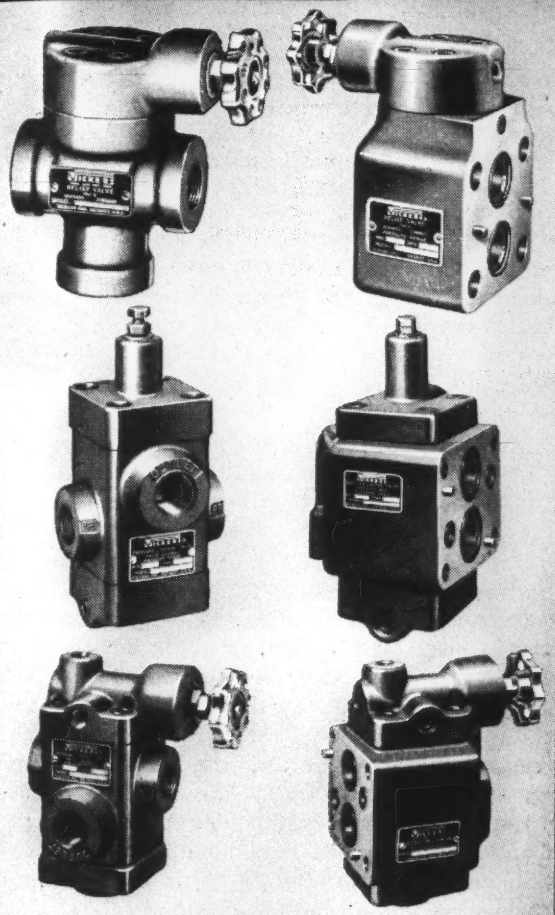


chamber, is rotated at one-half crankshaft speed through a vertical shaft and worm gearing. Lubrication is supplied to upper and lower bearing surfaces of the valve through drilled passages in the cylinder block. Oil pumped into zig-zag passages on the upper part of the valve is directed to the bearing surfaces only during the interval when sections of the grooves are aligned with passages in the cylinder block. Thus, the amount of lubrication to a particular bearing surface can be controlled by varying the length of time and number of times per revolution of the valve that the groove and outlet port, to that particular bearing, overlap. Briggs Manufacturing Co. has been assigned the patent, No. 2,516,976, by Waldo G. Gernandt.

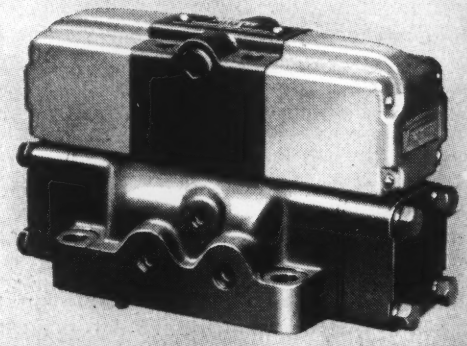
BALL-AND-SOCKET construction of a joint for coaxial cable permits swiveling about 60 degrees without introducing any electrical discontinuities in the system. The device is covered in patent 2,519,933, assigned to General Electric Co. by Charles L. Rouault. Ratio of diameters of inner and outer spherical joint members is kept equal to the ratio of inner and outer conductor diameters to maintain a constant impedance through the joint.



VICKERS PRESSURE CONTROL and DIRECTIONAL CONTROL VALVES



Vickers maximum pressure (relief) valves, pressure reducing valves, and sequence valves are constructed to limit maximum pressure adjustments within nominal working pressure range. Wires and seals can be used after final adjustment for locking.



Vickers pilot operated solenoid controlled, 2 and 3 position—4 connection type valves have oil- and water-tight solenoid enclosures and individual solenoid leads with terminals.

Give you the advantages

of J.I.C. Industrial Hydraulics Standards

The "Joint Industry Conference Hydraulics Standards for Industrial Equipment" have definite benefits for both the user and builder of machine tools and many other kinds of equipment. As these standards are directed toward assuring uninterrupted production of the machine, safety of personnel and longer equipment life (all without stifling hydraulic development), Vickers are participating in the J.I.C. program.

Shown at the left are representative Vickers Valves that comply with J.I.C. Standards. These valves embody proven design and construction features that provide dependability, greater accessibility for maintenance, simplification of piping and reduced installation costs. For further information ask for Catalog 5000.

VICKERS
Incorporated
DIVISION OF THE SPERRY CORPORATION

see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

1430 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices:
ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT HOUSTON • LOS ANGELES (Metropolitan) • MILWAUKEE • NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER • ROCKFORD • ST. LOUIS • SEATTLE • TULSA • WASHINGTON • WORCESTER

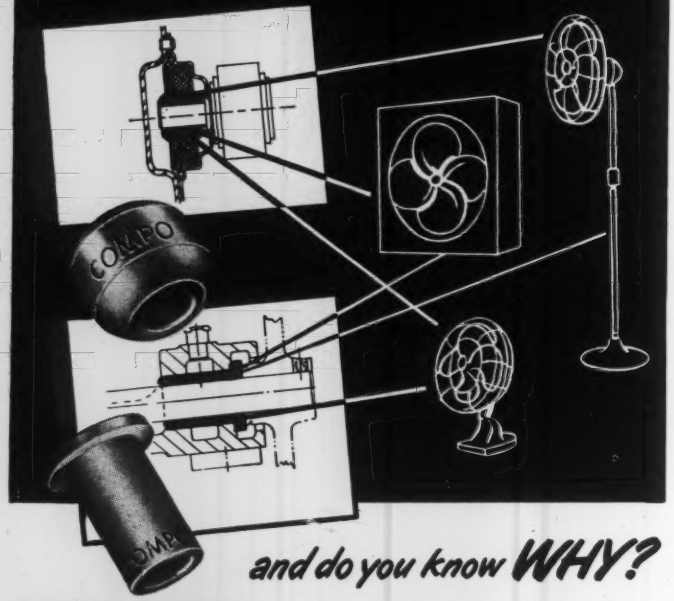
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

3558

Another Contribution to Industry through Powder Metallurgy by BOUND BROOK

DID YOU KNOW?

"COMPO"



and do you know WHY?

Because BOUND BROOK "COMPO" BEARINGS such as the self-aligning and flange bearings shown here, provide these advantages:

- impregnation with oils and lubricants *developed especially for fans by Bound Brook engineers*
- lubrication for long, dependable service
- extremely quiet operation.

BOUND BROOK "COMPO" bearings are:

- made from pure metal powders
- die-formed to shape
- alloyed at high temperatures
- finished to precise dimensions, AND
- vacuum-impregnated with lubricant

CONSULT OUR ENGINEERS

BOUND BROOK

"COMPO" • "POWDIRON" • BOUND BROOK

THE ENGINEER'S LIBRARY

Electrical Engineers' Handbook
Volume II—Electric Communication and Electronics

Edited by Harold Pender, consultant, Moore School of Electrical Engineering, University of Pennsylvania, and Knox McIlwain, chief consulting engineer, Hazeltine Electronics Corp.; published by John Wiley & Sons Inc., New York; 1587 pages, 5½ by 8½ inches, clothbound; available through MACHINE DESIGN, *$8.50 postpaid.*

Seventy-eight authorities in the fields of electronics and communications have contributed to the fourth edition of this handbook to make it of reference value to designers engaged in those fields and to all designers of equipment controlled electrically or electronically.

The opening sections of the volume present tabular and graphical data on mathematics and materials. The following sections, equally replete with tabular and graphical data, cover: resistors, inductors and capacitors; electron tubes; electric circuits, lines and fields; passive circuit elements; vacuum-tube circuit elements; frequency modulation; pulse techniques; transmission circuits; electrical measurements; acoustics; electromechanical acoustic devices; optics; electro-optical devices; sound-reproduction systems; telephony; telegraphy; facsimile transmission and reception; television; electronic control equipment; aids to navigation; and medical applications of electricity.

New in this fourth edition are the discussions of frequency modulation and pulse techniques as applied to the radar and communication fields. All sections have been rewritten to be in accord with the latest developments.

Manufacturer and Association Publications

ASTM Standards: This is the 1949 edition of a triennial publication containing the formally adopted American Society of Testing Materials standards, tentative specifications, methods of tests, and definitions. This edition, which is of value to engineers concerned with purchasing, design and production, is divided into the following volumes:

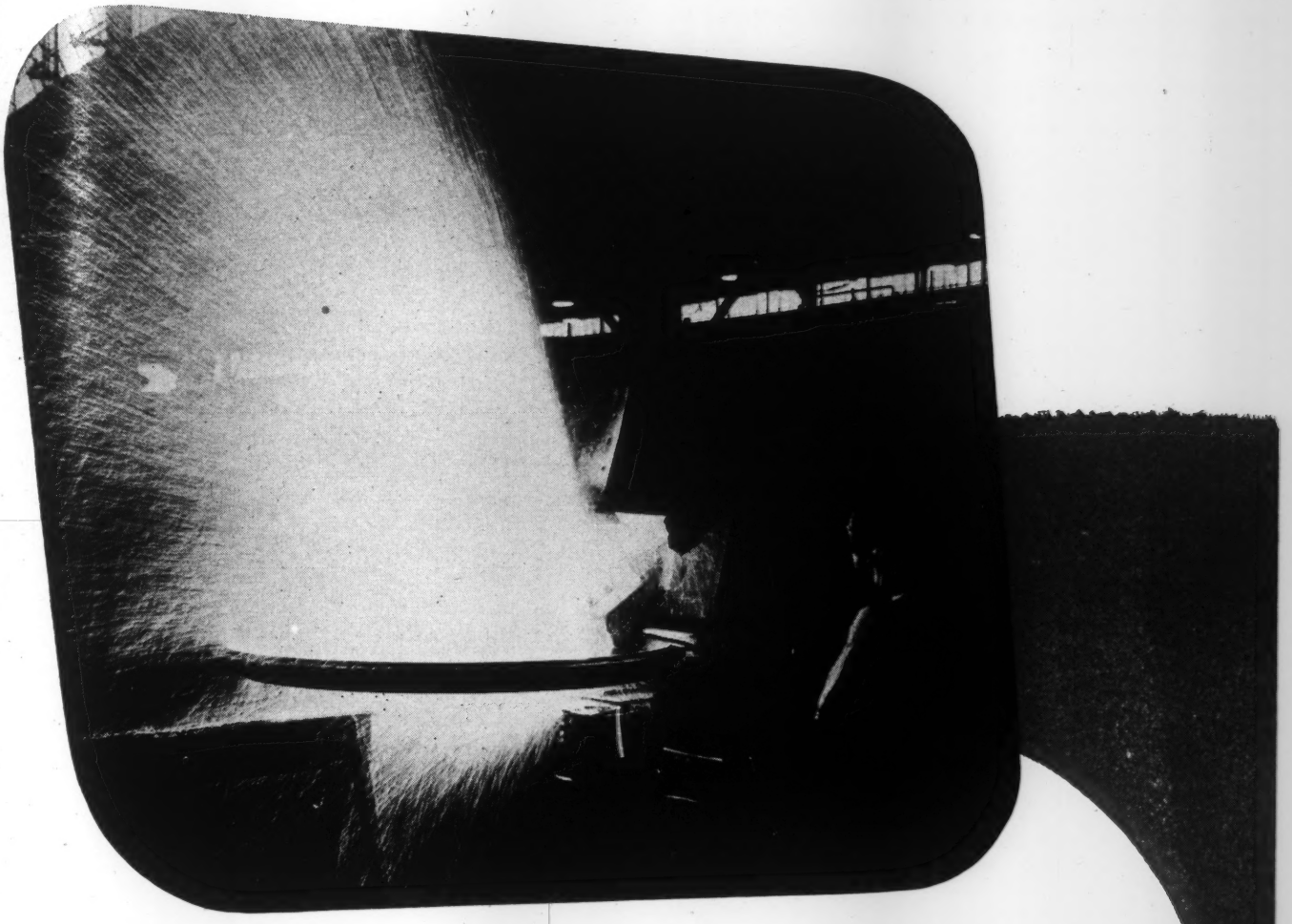
Part 1—Ferrous Metals: 265 standards; 1400 pages; $10.00 each, $7.50 to members

Part 2—Nonferrous Metals: 240 standards; 1170 pages; $8.00 each, $7.50 to members

Part 3—Cementitious, Soils, Road and Waterproofing Materials: 340 standards; 1370 pages; $8.00 each, $6.00 to members

Part 4—Paint, Wood, Adhesives, Shipping Containers and Paper: 325 standards; 1320 pages; $8.00 each, $6.00 to members

Part 5—Fuels, Petroleum, Aromatic Hydrocarbons, Soap, Water and Textiles: 330 standards; 1730



Fabrication-by-welding is being used by an ever-increasing number of careful, thorough buyers . . . and they are specifying American Welding.

A copy of our new 20-page illustrated catalog will be sent on request.

THE AMERICAN WELDING & MANUFACTURING CO.

130 DIETZ ROAD • WARREN, OHIO

PIONEERS IN FABRICATION BY WELDING SINCE 1918

pages; $10.00 each, $7.50 to members

Part 6—Electrical Insulation, Plastics and Rubber: 240 standards; 1410 pages; $10.00 each, $7.50 to members

Each part has a detailed index and two convenient tables of contents. A complete index to ASTM standards, approximately 260 pages, is furnished to all purchasers. Copies or complete sets may be purchased from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Hydraulic Fundamentals and Industrial Hydraulic Oils: A 44-page technical bulletin covering fundamental information on hydraulic systems and selection of proper fluids. Aside from the informative, well-organized text, this edition features specially prepared phantom and cutaway drawings illustrating effectively the functioning of basic types of valves, pumps, hydraulic motors, torque convertors, etc. This bulletin, identified as B-4, is a complete revision of the former bulletin of the same number. Copies may be obtained by directing company-letterhead requests to Sun Oil Co., Philadelphia 3, Pa.

Fiberglas Bibliography: This third edition, a quick-reference guide to relevant design data, contains annotated references to 710 articles describing the development, manufacture, properties, forms and uses of Fiberglas materials. Copies may be obtained from Edward C. Ames, public relations director, Owens-Corning Fiberglas Corp., Toledo 1, O.

Design Abstracts

(*Continued from Page* 177)

obtained is as apt to hurt as to help in the presentation of the machine. Good looks should be built in and should grow with the design.

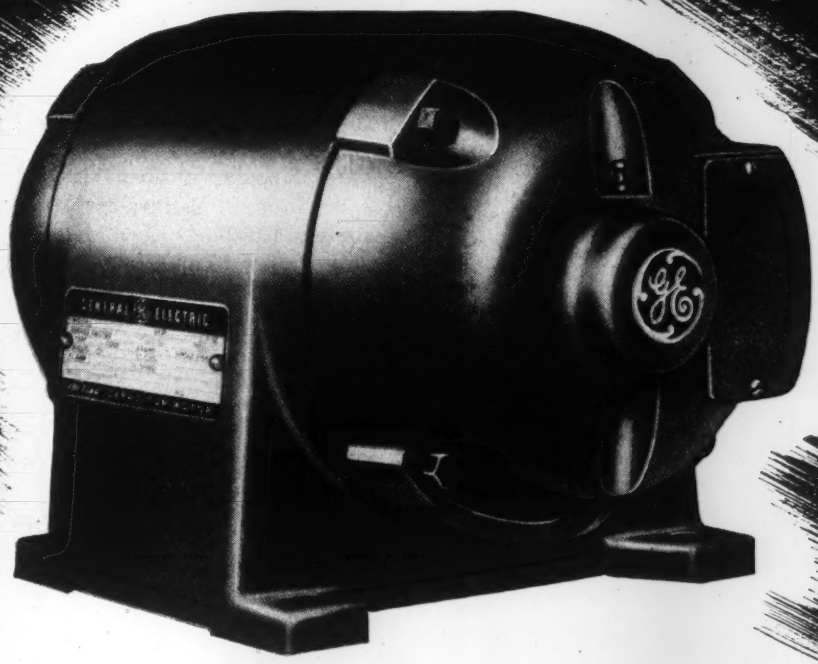
The stylist should be in close touch with the designers from the start of a design. In the early or fluid stages of a layout, there may be several possibilities in the arrangement of a mechanism and in the grouping of mechanisms to form a machine. At this time the suggestions of the stylist often can be adopted, and the planned appearance becomes an integral part of the machine.

Block Form: An expressive and useful design theme for machine tools is the "block form." It is an easy form to manipulate and is readily produced by fabrication and by casting. Square and rectilinear forms have a stable appearance and combine well with cylindrical members which are of course common in machine tools.

Edge Radii: Sharp edges where two planes intersect are not practical in castings and may look "tinny" in sheet metal or fabricated parts. In an effort to avoid sharp corners, designers are apt to go too far and, with generous radii, change a distinctive, modern design into a bulbous mass.

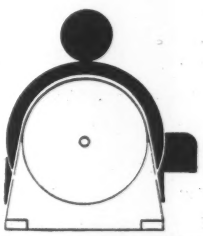
Corners: Die and tool charges must be kept low

Sales Getter!



NEW G-E CAPACITOR MOTOR

gives you these wanted features *plus* sales-stimulating eye appeal

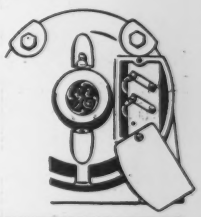


COMPACT DESIGN

Over-all dimensions are smaller because capacitor is in motor base. Weight is down 15 to 20 percent, too —your shipping costs are less.

EASIER INSTALLATION

A new terminal board in the end-shield takes the place of an exterior conduit box. Terminals are easy to get at, easy to wire.

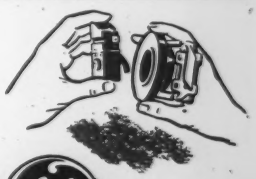


PRACTICALLY NO UPKEEP

Factory-greased bearings hardly ever need relubrication. When they do, a pressure-relief system makes it easy.

SMOOTH STARTING

Simple new centrifugal mechanism and totally enclosed starting switch give you smooth reliable starting—year in, year out.



ARRANGE TO SEE IT NOW!

Call your nearest G-E office for a demonstration. For complete details write for Bulletin GEA-5401. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

754-3

SINGLE-PHASE
CAPACITOR MOTORS 1 to 5 hp

NEW—

a Mighty Midget Built for Millions of Operations

semi-knife-edge bearing reduces frictional wear

This is Ward Leonard's new Bulletin 110 Midget Relay for long, trouble-free service, particularly in equipments subject to vibration.

Exceptionally good vibration characteristics are due to proper proportioning of contact masses and springing combined with heavy pressures on both normally open and normally closed contacts.

Higher contact ratings than most midgets. Available up to 3-pole, double throw. Contact finger leads are insulated with the new, impregnated glass-fiber tubing.

Write for Bulletin 110. Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

for machines manufactured in small lots. Since spherical corners or areas of compound curvature cannot be fabricated without dies, it is well to avoid such corners. Designs with cylindrical rather than spherical forms are readily possible.

Hiding Under a Bushel: Although the block form is useful, a designer must guard against the trend to wrap everything in rectangular packages. From long association we have learned to identify many machine members with a specific form. It is poor design to hide these well-known forms under a box. So hidden, distinctive functional mechanisms lose their identity and take on a monotonous similarity to too many products of industry. An electric motor has an easily recognized cylindrical form which through the years has evolved from the economical use of metal. Why wrap the motor up in a box or hide it under a bushel? It has a familiar, pleasing appearance; let it stand out and be recognized. Although the block form can be used effectively on machine tools it should be used with restraint.

Avoid Flutes on Large Castings

Flutes and Ribs: The beds and bases, columns and uprights of machine tools are generally made of cast iron; thus, good casting practices dictate many of the rules of styling. Flutes or ribs are not practical in large castings. An excessive amount of time is used in correcting or replacing them when they are distorted or lost in casting. Large castings are not scrapped just because an ornamental flute is imperfect. To avoid salvage work, leave flutes and ribs off large machine castings.

If ribs or flutes are to be used, they should be applied to the smaller or secondary units rather than to the main castings. On covers, plates, and doors, ribs are less likely to be deformed when molded and, if defective, the pieces can be replaced without serious loss. Ribs, especially when done in a contrasting finish, are distinctive, dignified, and in keeping with the geometric forms used on machine tools. However, it is suggested that ribs be used only if they make a positive contribution to the appearance of a machine.

Flush Type Covers: The designer will find little need for ribs and flutes if he has taken advantage of functional members of the machine as a means of providing interesting visual appeal. There is little logic in using flush type covers or compartment doors throughout the machine, with all the additional expense of manufacture and assembly, only to embellish them or other parts of the product with "speed lines" to retrieve some of the character which was so deliberately suppressed. Ease of cleaning may justify the smooth unbroken surfaces obtained with flush type covers but easy cleaning will not support the use of flutes or protruding decorations.

Expansive, unbroken, flat surfaces detract from the appearance of a machine. Since flush type covers often make large flat areas possible, they are not helpful in styling a machine. In general, a designer should try to break up large flat surfaces. A broad band or panel, elevated or relieved relative to the normal level of the surface will improve conditions

and will also assist in camouflaging any unsightly irregularities which appear in castings and which cannot be hidden by filling and painting. It is also possible to avoid flat areas by letting the encasement follow more intimately the enclosed mechanism, neither pursuing function too closely nor departing far from it.

Matching Castings: In the drive to get smooth surfaces, designers often call for matched castings so that the surfaces of two adjacent castings will appear as one. Here the designer must face reality. In practice the surfaces will not blend or match, and it is necessary to accept a noticeable and uneven intersection, or pay the serious costs of chipping and grinding. It is a much more practical approach to design for a deliberate step or break where castings meet. Casting variations will vary the height of the step but will not have a glaring effect on appearance, nor will they require added or corrective machining.

Streamlining: The purpose of getting streamline flow is to reduce resistance to motion. Thus the forms which best accomplish this have become associated with high speeds. A machine tool stays put—is often anchored to a floor of concrete—and there is no reason, why capabilities of high speed should be suggested. Occasionally one of the units on a machine tool can make valid use of streamlined forms.

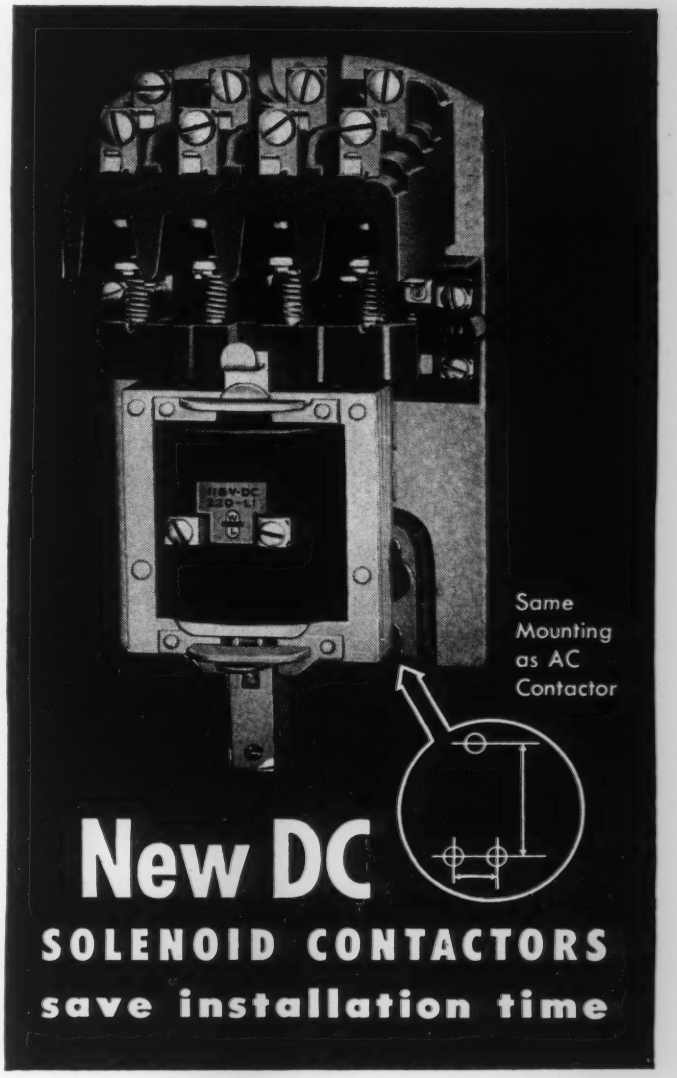
Use Few Bosses and Recesses

Flat Pads: One of the most aggravating sights in machine tools is the appearance of bosses or recesses framing every screw used to fasten auxiliary parts to the machine frame. There seems to be a common belief that holes cannot be drilled into a surface unless the axis of the hole is absolutely perpendicular to the surface. Even the slightest angle or curvature of the surface provokes the use of a flat pad, elevated or depressed beyond the normal surface, as though the screw head were something sacred, to be pointed out as the most important member of the machine.

Nameplates: Nearly every machine carries some sort of nameplate or identification. It also calls for other plates with instructions for operation, patent-number plates, and much other data. Some of these markings must be made visible. They can be treated to fulfill their intended function and at the same time become an attractive accessory, instead of being a necessary evil. No portion of the machine should be converted into a signboard. The manufacturer's name should be located prominently and by itself, not forced to share attention with a long address or with a list of patent numbers.

Conclusion: The styling of a machine tool can never be expected to instill in the beholder an insatiable desire for possession. However, there is no reason why a machine should appear awkward or ugly. Appearance can be made a natural or basic part of the machine and can contribute quietly in the presentation of the machine as a precision product, a master tool created to do an exacting job quickly. Let appearance help to portray function.

From a paper presented at the ASME Fall Meeting in Worcester, Mass., September 20, 1950.



New DC
SOLENOID CONTACTORS
save installation time

Unit construction—
Fit standard AC mounting

Now, with this modern, compact solenoid-type contactor . . . you'll no longer have the nuisance of drilling special holes for each component and furnishing special insulation.

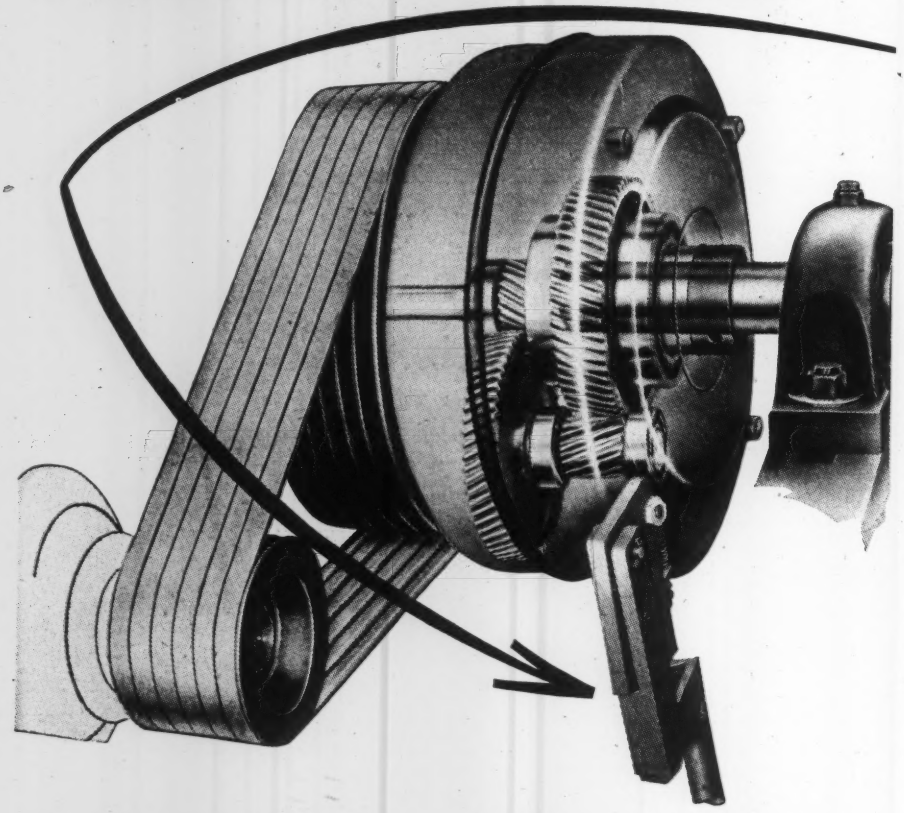
Ward Leonard's new Size 1, 2 and 3 DC Solenoid Contactors are *unit-insulated*—and have metal base plates which fit AC contactor dimensions.

Same accessibility of wiring as AC contactors . . . silver-to-silver contacts . . . components interchangeable with AC contactors.

Write for new Bulletin 1950. WARD LEONARD ELECTRIC CO., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD
ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

NEW OVERLOAD RELEASE



Provides Instantaneous Protection for Equipment Driven by AMERICAN REDUCTION DRIVES

The American torque-arm Overload Release provides another exclusive advantage for users of American Reduction Drives. It is a simple, foolproof device which automatically and instantaneously disengages the torque-arm from the reduction unit upon sudden shock loads or jamming condition. This disengagement permits the unit to revolve around its concentric input shaft and output hub, thus removing all torque from the driven machine and protecting equipment from damage. The Release is easily reset without tools and continues to provide the same overload protection indefinitely. Write for complete information on the application of this simple protective device for use with American Reduction Drives.

AMERICAN REDUCTION DRIVES

MAIL TODAY! *The American Pulley Company*
4238 Wissahickon Ave., Phila. 29, Pa.

Please send me complete information on the exclusive American torque-arm Overload Release for use with American Reduction Drives.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

NEWS OF MANUFACTURERS

Government officials and representatives of industry attended the formal opening of the new Harbor Island addition to the Kure Beach corrosion testing project near Wilmington, N. C., on November 15 and 16. With laboratory and exposure facilities for more than 20,000 specimens, the project is one of the largest units devoted to the study of effects of salt water and salt air on metals, alloys, nonmetallics, coatings and other materials. The project is under the direction of the **International Nickel Co. Inc.** A distinguishing feature, however, is that manufacturers regardless of competitive status freely exchange information and data. Much of the research is directed toward the solution of corrosion problems for U. S. Government service.

◆

Milwaukee Die Casting Co. is building a new plant in the 4100 block on North Holton St., Milwaukee, Wis. The new plant will contain 44,000 sq ft of floor space. A one-story structure covering 36,000 sq ft will house the production facilities; the remaining 8,000 sq ft on two levels will house the office, engineering departments, wash rooms, etc.

◆

Cornish Wire Co. Inc., manufacturer of radio, television and industrial wires, cord sets and specialty products for the communications industry, has moved to enlarged general executive offices at 50 Church St., New York 7, N. Y.

◆

Bijur Lubricating Corp. has moved its headquarters from Long Island City, N. Y., to Rochelle Park, N. J.

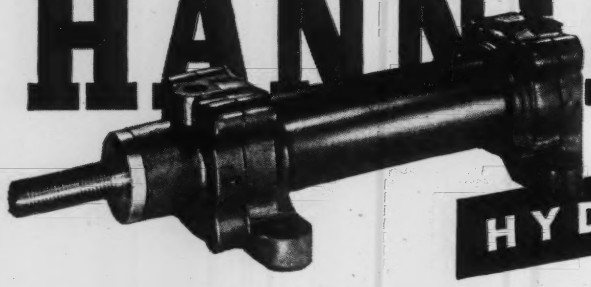
◆

General Electric Co. is expanding its jet engine manufacturing facilities at Lockland, O. Plans call for the procurement of additional factory space and the transfer of executive and engineering staffs from Lynn, Mass., to Lockland. Outside of these shifts, present operations at Lynn and nearby Everett, Mass., will not be changed. The additional space to be obtained at Lockland has not been decided upon. General Electric now occupies a portion of the plant at

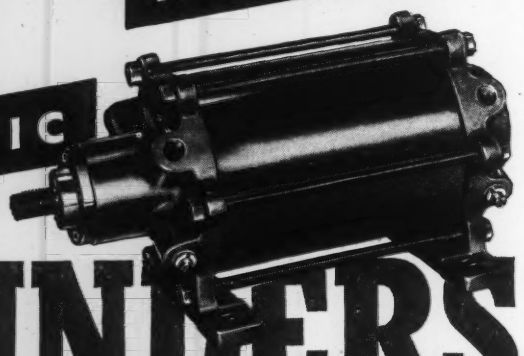
WE
WELCOME
SMALL
ORDERS
B
B

Here's Why it **PAYS** *to Use*

HANNIFIN



HYDRAULIC



PNEUMATIC

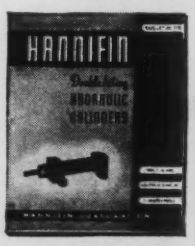
CYLINDERS

1. **QUICKER DELIVERY!** You can get cylinders to meet virtually any need out of the Hannifin standard line. Save time and money right from the start by checking with Hannifin on all of your cylinder requirements.

2. **EVERYTHING YOU WANT!** Wide choice of mounting styles. Any length stroke. Adjustable cushions for head end, rod end, or both. Single or double end rods. Air Cylinders in standard sizes from 1" to 16"; Hydraulic Cylinders, 1" to 8". Larger or special types to order. "Hy-Power" cylinders for pressures to 5,000 p.s.i.

3. **SUPERIOR DESIGN AND CONSTRUCTION!** A precision-built product; latest, most advanced design features; unexcelled quality.

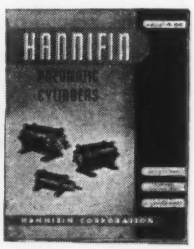
4. **WORK BETTER! LAST LONGER!** The choice of engineers and machinery builders for more than 40 years. Less trouble, less maintenance. For recommendations, see your local Hannifin representative, or write.



HYDRAULIC CYLINDERS
Bulletin 110

ASK FOR BULLETINS

Hannifin
CORPORATION
1115 S. Kilbourn Ave.
Chicago 24, Illinois



AIR CYLINDERS
Bulletin 210

Lockland in which Wright piston engines for aircraft were manufactured during World War II. This is leased from the Electric Auto-Lite Corp., Toledo, O.

♦

Kano Laboratories, manufacturer of lubricants, gasoline motor purges, rustproofing compounds, etc., has erected an aluminum covered plant at 1000 S. Thompson Lane, Nashville 11, Tenn. The building is approximately four times as large as Kano's former Chicago quarters.

♦

Diamond Alkali Co., Cleveland, O., has purchased the chromic acid business of **E. I. du Pont de Nemours and Co.,** Wilmington, Del. The product will continue to be produced by du Pont at its Philadelphia plant; Diamond will take over distribution on January 1, 1951. Diamond's entry into the chromic acid business represents a logical diversification of its line of chromium chemicals.

♦

Tinnerman Products Inc., Cleveland, O., manufacturer of Speed Nut fasteners, will construct a new research laboratory adjacent to its new $2,000,000 plant which was formally opened in September.

♦

Drake Mfg. Co., 1711 W. Hubbard St., Chicago 22, Ill., has acquired all the manufacturing and sales rights to the special neon-glow indicator lights formerly made and distributed by Littelfuse Inc. The pilot type lights are designed for use on all kinds of electrically operated equipment including household and industrial appliances and radio and TV panels.

♦

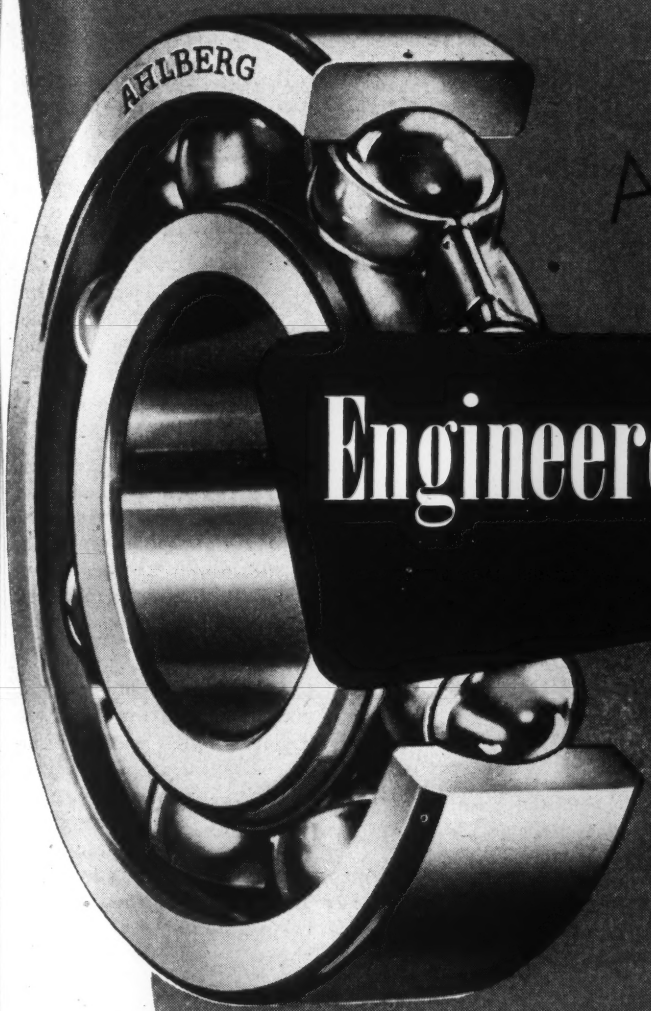
The **F. J. Stokes Co.,** Philadelphia, Pa., manufacturer of industrial machinery, has begun a $700,000 expansion program designed to add one-third space to the present plant. Completion is scheduled for early 1951. Some of the additions to the plant will be a relocation of the railroad siding and enlarging of roadways, the expansion of laboratory facilities with new equipment, the installation of precision testing and inspection apparatus, and the addition of many new high-speed machine tools.

♦

Allis-Chalmers Rumley Ltd., a Canadian subsidiary of **Allis-Chalmers Mfg. Co.,** Milwaukee, Wis., has purchased the plant of the Erie Iron Works, St. Thomas, Ontario, and also an additional seven acres of land from

AHLBERG

PRECISION ANTI-FRICTION PRODUCTS



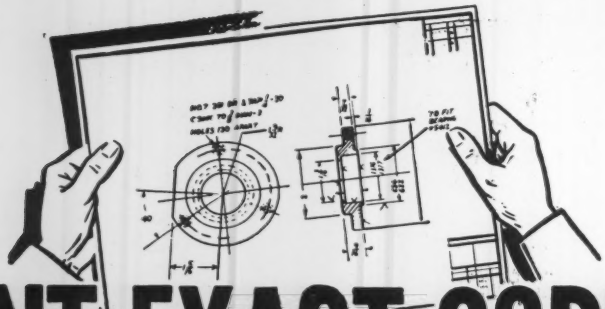
Engineered *for Super Service*

It's well to remember, when you're thinking of power transmission and operating costs, that only smooth power is truly efficient, truly economical power. And smooth power can only come from machines properly and adequately equipped with bearings specifically engineered to deliver super service . . . for example AHLBERG bearings. Try, test and compare Ahlberg bearings. We believe you'll decide your dollars can't buy better performance than these fine bearings give. Reasons? Well, if you were to micro-analyze any Ahlberg ball bearing, you would find . . . balls that are accurate to .000025" in sphericity, matched in sets to .000025" . . . "generated" raceways that assure true race curvature . . . chrome alloy electric furnace steel that is meticulously heat-treated for maximum toughness without brittleness. In all other ways from blue print inception to final inspection, Ahlberg bearings are . . . precision made—with precision mated components. Complete engineering assistance and quotations without obligation.

AHLBERG BEARING COMPANY
3023 West 47th Street, Chicago 32, Illinois
Precision Craftsmen Since 1908

AHLBERG BALL BEARINGS • ROLLER BEARINGS • THRUST BEARINGS AND BALL BEARING HOUSINGS

DISTRIBUTORS IN ALL PRINCIPAL INDUSTRIAL AREAS



WANT EXACT COPIES AT LOW COST?

You'll get them with a Bruning Whiteprinter

Copy your drawings, records, and reports *exactly* and *economically* with a Bruning Whiteprinter. You'll get crisp, smudgeproof, errorproof copies — at low cost — and *fast!*

Just place your original on a sheet of Bruning Whiteprint paper and insert both into the Whiteprinter. Within seconds, out comes an easy-to-read, completely developed *positive* print.*

You can make an unlimited quantity of prints — any size up to 42" wide by any length — in black-on-white or any of 20 color combinations. They come out flat, dry, stacked. The last copy is as clean and sharp as the first. Five models offer a complete range of capacities.

NEEDS NO EXHAUST DUCT OR PLUMBING

Avoid installation troubles with a Bruning Whiteprinter. It is mobile — requires no plumbing, no exhaust duct; you need only connect it to your electric supply.

Get the top-quality copies you want. Get them inexpensively and *on time.* Get a Bruning Whiteprinter! For full description, send coupon or write *Charles Bruning Company, Inc., Dept. E-120, 100 Reade St., New York.*

BRUNING WHITEPRINTERS

PERFECT PRINTS . . . WITHIN SECONDS . . . FOR PENNIES

**If your original is opaque, the Whiteprinter quickly copies it onto translucent stock from which you make as many Whiteprints as you want.*

CHARLES BRUNING COMPANY, INC.

Dept. E-120, 100 Reade St., New York, N. Y. Offices in principal cities

Please send me free Booklet A-1056 describing the Bruning Whiteprint Process.

Name_____

Company_____ Position_____

Address_____

City_____ Zone____ State_____

the city. By the first of the year, the company hopes to install machine tools for manufacturing operations; until that time, however, assembly operations will be carried out. Foremost among the products produced will be controls for diesel locomotives manufactured by the General Motors diesel plant of London, Ontario.

♦

In line with its policy of integrating all operations at its Carnegie plant, **American Cladmetals Co.**, Carnegie, Pa., is installing a thirty-inch wide cold rolling mill to be completed in 1951. Purchased from Jones & Laughlin Steel Co., the mill was in operation at that company's Otis Works, Cleveland, O. Auxiliary finishing and automatic handling equipment will be installed with the mill which was designed and built by the Mesta Machine Co.

♦

A new consulting engineering firm, **Skinner, Harlan and Ireland Inc.**, has been organized with offices and laboratory in Indianapolis, Ind. The firm will specialize in permanent magnets and soft magnetic materials and problems in allied fields.

♦

Completion of an expansion program to double production of stress-relieved silver brazing and soldering preforms for the metal working industry has been announced by the **Lucas - Milhaupt Engineering Co.**, 5057 South Lake Dr., Cudahy, Wis. The program includes the addition of specially designed equipment and an increase in production staff.

♦

Beaver Industries, 1500 W. Adams St., Chicago 7, Ill., manufacturer of screw machine products, is planning the addition of a cold-heading department. Additional equipment will be devoted to increasing the present capacity of 5,000,000 screws per month.

♦

H. K. Porter Co. Inc. has sold its locomotive business, including patterns, drawings and spare parts business, to **Davenport-Besler Corp.** (Davenport Locomotive Works), Davenport, Ia. Davenport will service all Porter locomotives now in operation as well as build duplicate locomotives including the Porter fireless locomotive.

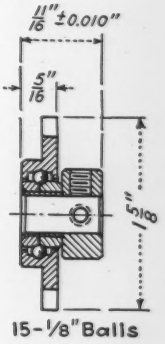
♦

General Electric Co.'s new measurements laboratory, Lynn, Mass., is in operation. Staffed by engineering specialists in magnetism, electricity, chemistry, metallurgy, sound, heat, light and color, the new laboratory

"Commercial" Ball-Bearing Data...#10 of a Series

WE WILL BE GLAD TO SEND YOU COPIES OF THE PREVIOUS ADVERTISEMENTS IN THIS SERIES.

How a special low-cost ball bearing eliminated assembly rejects

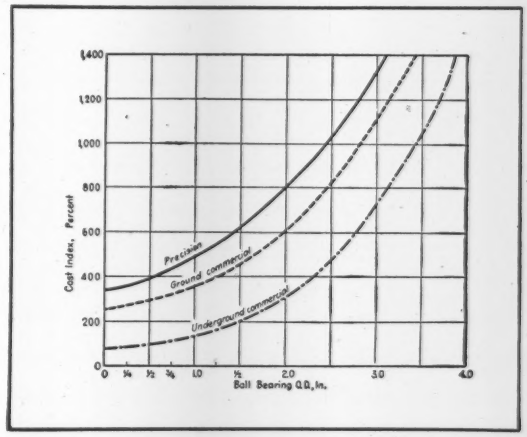


This Schatz "Commercial" Ball Bearing was specially designed to support the thread spool on a textile weaving machine operating at 2500 RPM under a 20-pound load. Previously, the spool had been held by a slotted washer, spot-welded to a standard bearing. Rejects were high, since the heat of the welding operation caused distortion of the balls and races.

Schatz engineers designed a new bearing with a split inner race and a flanged outer race to replace the washer. Result: the bearing could be used immediately without the costly spot-welding operation, and rejections due to heat distortion were completely eliminated.

Special "Commercial" Ball Bearings—like the one shown—are often less expensive than standard bearings, since costly assembly and machining time is eliminated. And many difficult anti-friction problems can be solved by various modifications in materials, inner and outer races or the ball arrangement. All "Commercials" can be furnished with single or double row of balls, felt or labyrinth seals, flanged or plain outside diameters, hardened or unhardened treads, set screws, Alemite fittings, extended inner race and hexagonal bores.

We will be glad to adapt or design a low-cost Special Ball Bearing to fit your specific job requirements.



Relative costs of precision and "Commercial" Ball bearings. In very small sizes, the cost of precision bearings *increases* as the bore decreases, due to the difficulty in maintaining close tolerances. The cost of "Commercials" *decreases* in almost direct proportion to the size.

Write for "Construction and Characteristics of Low-Cost Ball Bearings." It tells how to select low-cost Schatz "Commercial" Ball Bearings for various load and speed conditions, gives classifications of standard types for radial, thrust or combination loads, and discusses the modifications that can be made for special design, assembly or operating conditions. Ask for Catalog No. 11, too. It gives complete data on the whole "Commercial" line.

SCHATZ
"Commercial"
BALL BEARINGS

The Schatz Manufacturing Company
6760 FAIRVIEW AVENUE, POUGHKEEPSIE, N. Y.

If your designs call for metal plus the chemical resistance, toughness, electrical insulation, or smooth "feel" of hard rubber, use these

3 WAYS TO COMBINE HARD RUBBER AND METAL

1. *Molded Inserts:* Follow standard molding design practice. Magneto part above is good example. Seventeen inserts are molded into high dielectric Magnon Super Ace compound (dielectric strength 600 v/mil at 60 cycles). This Ace grade gives durable strength up to 300°F.

2. *Shrink Fits:* Screwdriver is insulated by slipping hard rubber tube softened in hot water over shank, then slipping heat-softened hard rubber handle over both shank and tube. Rubber cools, shrinks, gives positive-grip, insulated tool as no other material can do. An idea for you?

3. *Vulcanized Cement Bond:* Two-layer process: Hard rubber outer layer for best resistance to chemicals and aging; live, soft-rubber inner layer provides resilience. These Ace linings also can be all-hard or all-soft rubber, natural or synthetic.

Ask for ACE Handbook, a gold mine of helpful information

ACE Since 1851 — HARD RUBBER and PLASTICS

AMERICAN HARD RUBBER COMPANY

11 MERCER STREET • NEW YORK 13, N. Y.

contains complete facilities for applied research, product development and design in the field of measurements. The five-story, steel and concrete building has 142,000 sq ft of floor space, the major portion of which is occupied by the laboratory; the remainder, by administrative staffs of the G-E Meter and Instrument Divisions.

♦

H. K. Porter Co. Inc., Pittsburgh, Pa., has acquired Connors Steel Co. Inc., Birmingham, Ala., manufacturer of electric furnace steel and steel products. This move was made to further diversify Porter operations which already include industrial rubber products, oil well equipment, valves and air brake parts and railroad springs.

♦

The first of the nation's all-purpose synthetic rubber plants to be reactivated under the government's expanded rubber program is in production. The plant, Port Neches, Tex., was designed for a production capacity of 60,000 long tons a year. Thorough modernization by engineers of the **United States Rubber Co.** has raised the annual production capacity peak to 72,000 long tons.

♦

The New Jersey Zinc Co. has added a battery of nine new vertical retorts at its Palmerton, Pa., plant bringing the total to 43 retorts. The new retorts, which incorporate several design improvements, have approximately 25 per cent greater capacity per retort than those of the older batteries.

♦

Dow Chemical Co. has started construction on a new plant near New London, Conn., for the manufacture of Styron, a Dow plastic. The 80-acre site of the new plant is located on the Thames River and Dow plans to ship some raw materials directly from its Texas division via water route. Completion of the plant is expected within a year.

♦

Synchro-Start Products Inc., Chicago, Ill., manufacturer of automatic engine control equipment, has begun the erection of the first unit of its new factory located in the Village of Skokie, northwest of Chicago.

♦

Lenkurt Electric Co., San Carlos, Calif., has begun a construction project to add 16,000 sq ft to its plant. The company, which also has a plant in Vancouver, B. C., manufactures radio and wireline telephone and telegraph carrier equipment.

Are 10,000 pumps enough for you?

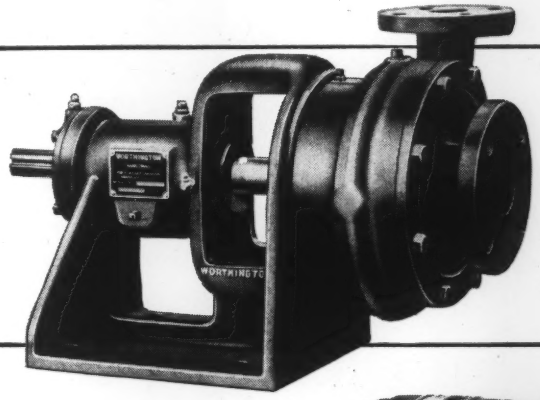
Just about. It takes that many different combinations to make sure that you—big user or small user—get exactly the right pump you need.

That's why we manufacture Worthington centrifugal pumps in over 10,000 standard combinations of capacities, heads, casings and mountings.

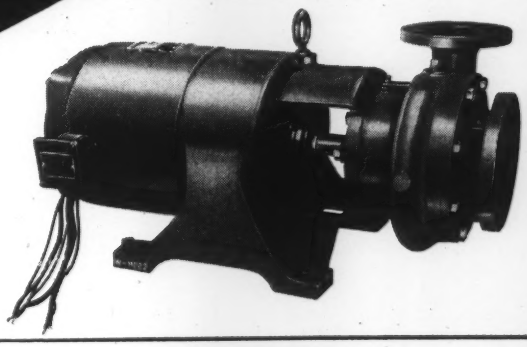
Types CN (frame-mounted) and DN (built-in motor) are made in capacities from 10 to 1800 gpm, heads to 535 ft., with 40 sizes of pump casings and 200 combinations of frame-mounted designs.

And—maximum interchangeability of parts!

Get the habit of asking for a Worthington—you'll get exactly the pump you want.



Type CN, frame-mounted, is a real "any-drive" pump—readily driven by electric motor, V-belt, or any other source of mechanical power.



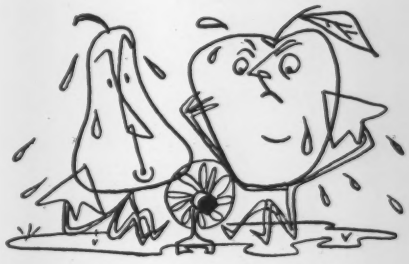
Type DN is the famous Worthington Monobloc design—compact, streamlined, with built-in motor. On both types, liquid ends are interchangeable, and can be equipped with either conventional packing or mechanical seal.

WORTHINGTON

THE GOOD RIGHT HAND OF INDUSTRY

POWER TRANSMISSION: sheaves, V-belts, variable speed drives. **PUMPS:** centrifugal, power, rotary, steam. **AIR COMPRESSORS:** water-cooled, air-cooled. PC.O.8

The Fruit Was in a Sweat



. . . and So Was the Pump

They suddenly began having a hot time of it at a fruit and produce company near the Dillon Supply Company in Raleigh, N. C.

A centrifugal pump used in their refrigeration system had called it a day, and the temperature was rising in the rooms where the produce was kept. Without refrigeration, the perishables would have indeed perished.

But a frantic call to Dillon located, in the distributor's stock of Worthington centrifugal pumps, exactly the size needed. Prompt delivery . . . and not a lettuce leaf was allowed to wilt.

It's another example of the wisdom of depending on your Worthington Distributor. No distributor offers *more* pumps . . . no distributor offers more *value* in pumps . . . than a Worthington distributor.

Worthington Pump and Machinery Corp.
Pump and Compressor Merchandising Div.
Harrison, N. J.

Send latest bulletin on Worthington Centrifugal Pumps. Any other (type).....

Name.....

Company.....

Address.....

City.....State.....

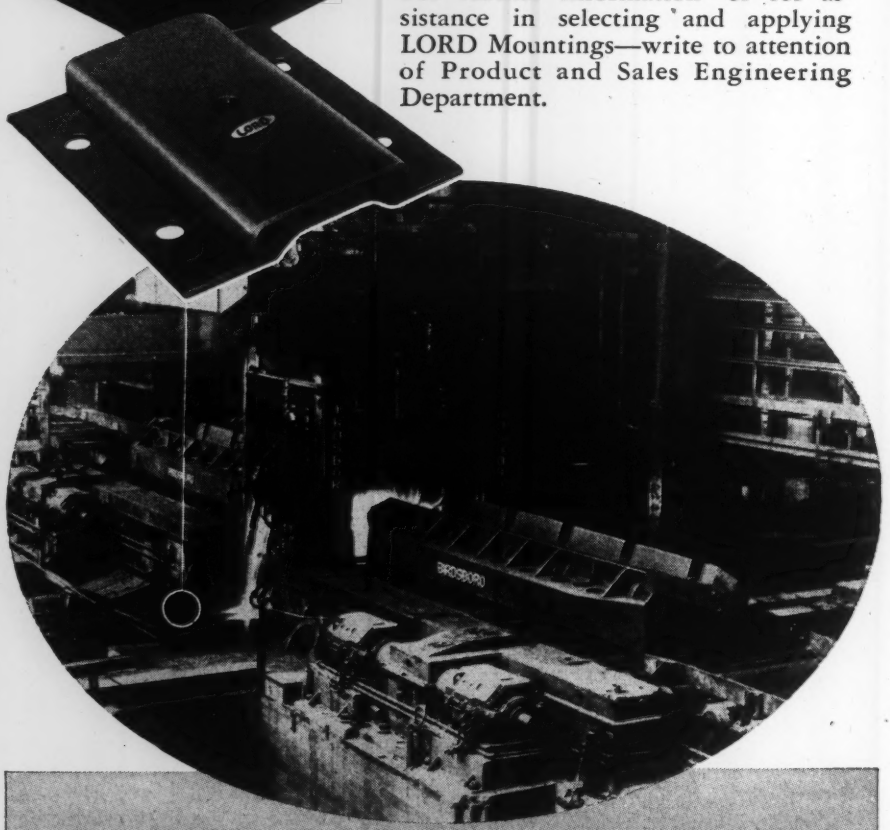
in HEAVY INDUSTRY, too, LORD MOUNTINGS

Furnish Shock Protection

This Birdsboro Blooming Mill illustrates how LORD Mountings effect economies in machine design, and how they protect working parts against damage from shock loads. Steel ingots and slabs are manipulated on the table at left of mill. They drop several inches during turning and rolling operations, creating heavy shock loads on table rollers and bearings.

By incorporating LORD Industrial Shockmounts into the design, Birdsboro engineers were able to greatly increase the capacity of an existing table design with a moderate increase in cost, where otherwise a very heavy table at considerable additional cost would be required. A faster acting table was obtained . . . bearing and roller stresses were reduced . . . service life was lengthened . . . maintenance was lowered.

LORD Mountings improve product performance . . . make machines operate smoothly and quietly . . . add sales appeal and customer satisfaction . . . often reduce manufacturing and assembly costs. Designers should investigate the advantage of LORD Mountings for both heavy and light equipment. For further information—or for assistance in selecting and applying LORD Mountings—write to attention of Product and Sales Engineering Department.



LORD MANUFACTURING COMPANY • ERIE, PA.

Canadian Representative: RAILWAY & POWER ENGINEERING CORP. LTD.

LORD BONDED RUBBER

Vibration-Control Mountings . . . Bonded-Rubber Parts

SOCIETY ACTIVITIES

Several noteworthy events occurred during the **America Welding Society's** thirty-first Annual Meeting, Chicago, Ill.

Election of Officers: President—Harry W. Pierce, assistant to the president, New York Shipbuilding Corp. First Vice President—Charles H. Jennings, engineering manager, welding department, Westinghouse Electric Corp. Mr. Jennings was also selected as the 1950 Adams Lecturer, an honor awarded annually to an outstanding welding scientist or engineer. Second Vice President—Fred L. Plummer, director of engineering, Hammond Iron Works.

Lincoln Gold Medal Award: Presented to Howard S. Avery, research metallurgist, American Brake Shoe Co. This honor is awarded annually by the Society to the author of the paper adjudged the greatest original contribution to the advancement and use of welding. Mr. Avery's winning paper was entitled "Hot Hardness of Hardfacing Alloys."

Samuel Wylie Miller Memorial Medal: Presented to Dr. Wendall F. Hess, head of the department of metallurgical engineering, Rensselaer Polytechnic Institute. Dr. Hess was signaled for this honor because of his conspicuous contributions to the advancement of welding and cutting of metals.

Resistance Welder Prizes: This prize contest is sponsored by the Resistance Welder Manufacturers Associations. The more than $2000 in prizes are made through the American Welding Society. This year's awards were presented to the following: First Prize of $750 for the best paper from an industrial source to J. W. Kehoe, Westinghouse Electric Corp., for his paper "A Practical Method for Obtaining Consistent Resistance Welds."

Second Prize of $500 to three Franklin Institute engineers: A. O. Bergholm, P. W. Swartz and G. S. Hoell for their paper "Stress Distribution Around Spot Welds."

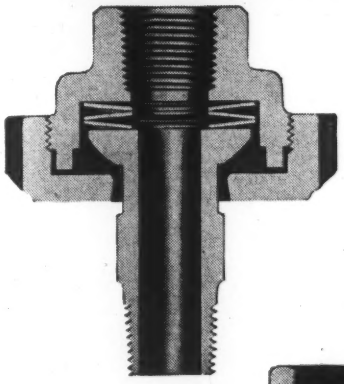
Third Prize of $250 to I. S. Goodman, Westinghouse Electric Corp., for his paper "Variables in Cross-Wire Welding of Dissimilar Metals."

For the best paper from a university source, Dr. Georges Welter, Ecole

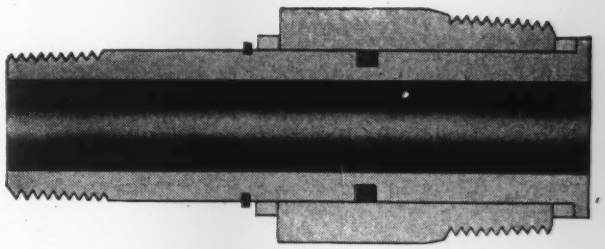
BARCO Flexible, Swivel and Revolving Joints

A complete range of design

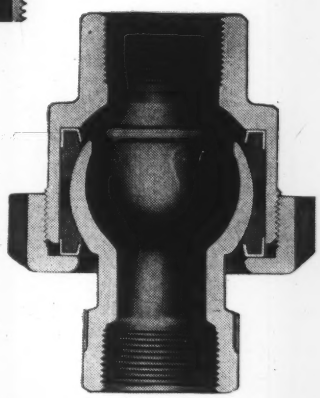
Select the one fitted to your specific needs



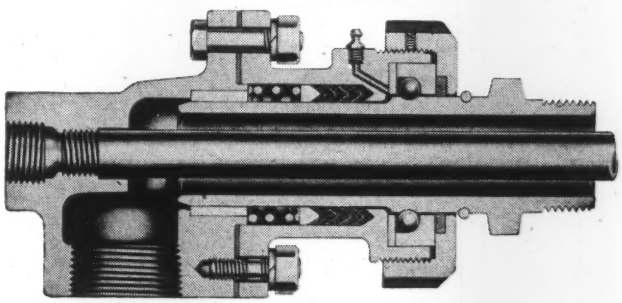
Barco Rotary Swivel Joints for use with air, oil, gas, steam, water and other fluids provide slow rotation with side flexibility.



Barco Swing Joint for hose reels, loading and unloading lines, and for tank cars and trucks—compact, inexpensive, durable.



Barco Flexible Joints for conveying oil, steam, gasoline, water, tar, corrosive acids and alkalis —where flexibility in piping is required.



Barco Revolving Joints supply steam, gas or other fluids from a fixed supply pipe to a rotating drum or member with low friction "drag." Sizes from ¼" to 5".

There is a Barco Joint for each particular problem in pipe flexibility. Different designs are available for:

- **Combined angular and swivel motion**
- **Swivel and slow rotation combined with angular motion**
- **Swing action with no side flexibility**
- **High-speed rotation**

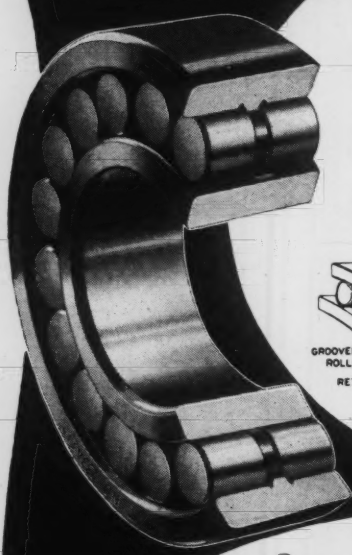
There's a Barco Joint to handle any type of fluid with wide temperature and pressure ranges and a variety of metals and gasket materials. For more information about this *complete* line of joints, write Barco Manufacturing Company, 1806M Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal.

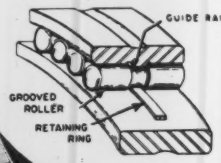
BARCO THE ONLY TRULY COMPLETE LINE OF FLEXIBLE, SWIVEL AND REVOLVING JOINTS

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

another FIRST in
McGILL precision bearings

a
NEW PRINCIPLE
in
roller bearing design

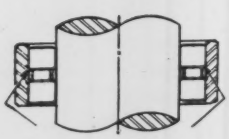




Rollers cannot skew. A guide rail integral with the outer race maintains alignment of the grooved rollers.

The NEW McGILL® GUIDEROL roller bearing

The Bearing with the Self-Aligning Rollers — a simplified roller bearing construction that automatically corrects roller skewing — without space wasting cages! Perfect roller alignment with resulting superior performance is maintained by this new principle of guided rollers. Even with reduced internal radial looseness a GUIDEROL bearing overcomes any tendency to bind under limited misalignment. Produced in needle and cylindrical type roller bearings. Write for information packed Bulletin today.

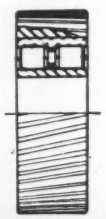


UNIVERSAL MOUNTING

Universal Mounting — from horizontal to vertical is possible. No cocking of rollers on vertical shafts because the grooved rollers are located by guide rail.

OPEN ENDS — SELF CLEANING

Open Ends — Self cleaning in applications permitting free circulation of oil or grease. Open faces set up flushing action inside the bearing.



GREATER ANGULAR RIGIDITY

Greater Angular Rigidity is provided by longer rollers that permit race and roller contact virtually to the outside edges of the races.

Write for your copy of the new GUIDEROL Bearing Bulletin No. GR-50. Address: McGill Manufacturing Co., Inc., Bearing Division, 200 N. Lafayette Street, Valparaiso, Indiana.

McGILL® precision bearings

Polytechnique, University of Montreal, Canada, was selected the winner of the $300 first prize for his paper, "Fatigue Tests of Spot-Welded Steel Sheets." The second prize of $250 went to Dr. W. B. Kouwenhoven, The Johns Hopkins Institute and Dr. W. T. Sackett, Jr., Battelle Memorial Institute for their paper, "Electrical Resistance Offered to Nonuniform Current Flow."

♦

The **National Association of Engineering Companies** (NAEC) will hold its National Mobilization meeting, December 12, 1950, at the Detroit-Leland Hotel, Detroit, Mich. Attendance is open to representatives of any engineering company whose services include: machine and tool engineering or design; product engineering on mechanical products; or production, processes or methods engineering. In line with its basic concept which essentially is to coordinate, counsel and improve the economy of the industry it represents, NAEC is preparing a classified index of engineering services and total capacities in individual engineering companies. Such an index will facilitate the association's function as a clearing house for government agencies, contractors and industrial buyers for quickly locating needed design and engineering capacity of any type within the scope of NAEC.

♦

James C. Zeder, president of the **Society of Automotive Engineers,** announced that the Society has been called upon to assist the U. S. Armed Services with technical consulting service as it did during World Wars I and II. A recent meeting with top echelons of the services has resulted in subsequent interchanges on specific project possibilities by which SAE will provide aid and counsel.

♦

During its Annual Meeting, Nassau Tavern, Princeton, N. J., the **Society of Industrial Designers** elected Dave Chapman, Chicago industrial designer, president for the coming year. Other officers elected are: Viktor Scheckengost, Cleveland, vice president; Robert Hose, New York, secretary; and A. Baker Barnhart, New York, treasurer.

♦

The Society of Automotive Engineers' 1949 **Horning Memorial Award** will be presented to Dr. Daniel P. Barnard IV, research coordinator for the Standard Oil Co. of Indiana at the Society's 1951 Annual Meeting in Detroit. Dr. Barnard will receive the award in recognition of distin-

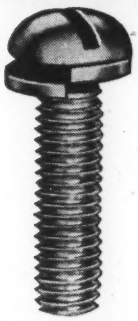
RELIANCE SPRING LOCK WASHERS

for dependable, enduring bolt tightness

Compact, inexpensive, Reliance Spring Lock Washers act as hardened thrust bearings . . . make possible tighter assemblies. Made of cold drawn spring steel, their powerful coil-spring tension compensates for wear and bolt stretch . . . keeps bolted assemblies tighter longer.

3 ways to

- **CUT COSTS**
- **SPEED PRODUCTION**
- **IMPROVE PRODUCTS**



EATON SPRINGTITES

speed assemblies

cut costs

Eaton Springtites are quality Reliance Spring Lock Washers pre-assembled on bolts or screws so they can't come off. They speed assemblies, eliminate loss, prevent use of wrong washer, simplify inventories—cut costs.

RELIANCE RINGS

cut machining time

reduce material costs

Reliance Rings snap into grooves in shafts or counterbores, forming strong shoulders without tedious, costly machining and waste of material. Easily removed when necessary. Open or welded, any diameter, cross section or end cut.

EATON

EATON MANUFACTURING COMPANY

Reliance Division

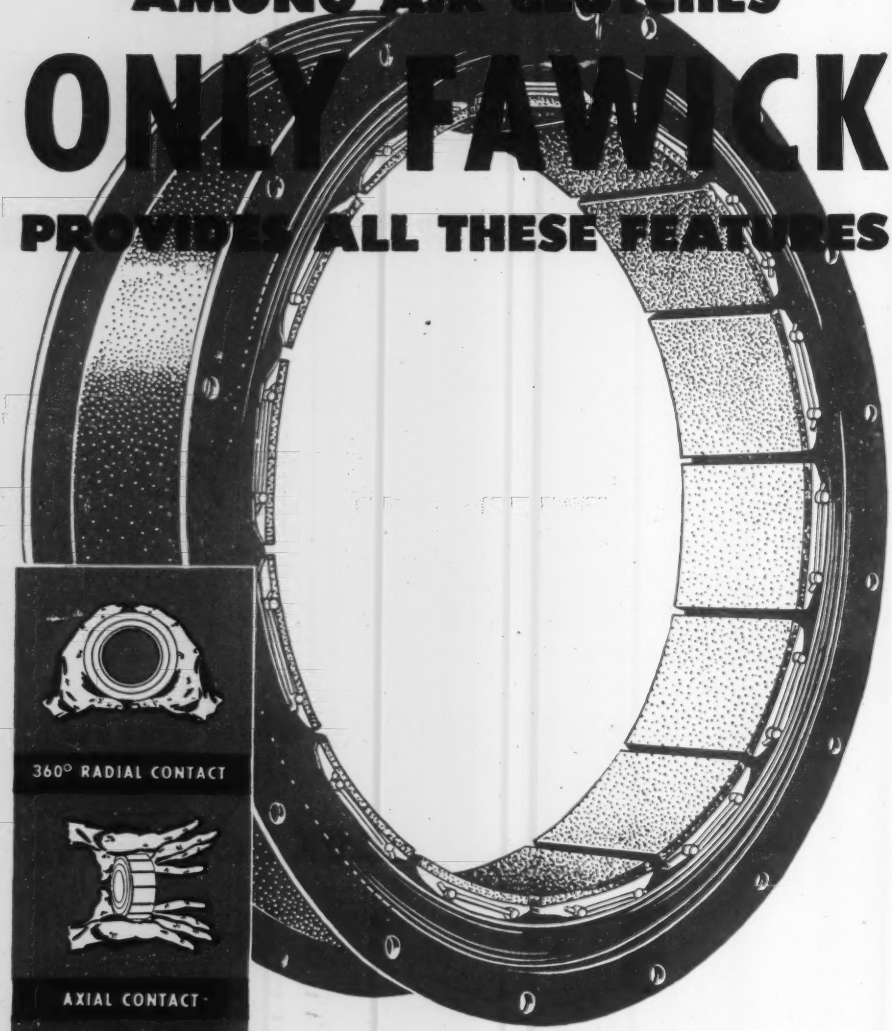
OFFICES AND PLANT **MASSILLON, OHIO**

Sales Offices: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

AMONG AIR CLUTCHES

ONLY FAWICK

PROVIDES ALL THESE FEATURES



360° RADIAL CONTACT

AXIAL CONTACT

SHOCK ABSORPTION

CONTROLLED TORQUE

360° RADIAL CONTACT—Application of the operating pressure at the maximum diameter results in the greatest operating torque.

AXIAL CONTACT—Fawick design provides uniform-pressure, constant-velocity contact between the full width of the friction shoes and the drum.

SHOCK ABSORPTION—Operating torque is transmitted through the flexible rubber tube, dampening shaft vibrations and cushioning peak load shocks.

CONTROLLED TORQUE—Variation of operating pressure makes sensitive control of applied torque possible. Peak overload protection is assured at a selected air pressure.

For specific information on all advantages of Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 300.

All desirable clutch characteristics are built into Fawick Airflex units

FAWICK Airflex CO., INC.

9919 CLINTON ROAD CLEVELAND 11, OHIO

FAWICK CLUTCHES = = PEAK EFFICIENCY

AXIAL CONTACT 360° RADIAL CONTACT SHOCK ABSORPTION CONTROLLED TORQUE

guished active service in the field of mutual adaptation of fuels and engines.

♦

The **Metal Treating Institute**, New Rochelle, N. Y., has begun publication of a monthly magazine, *Metal Treating*, as the official journal of the organization whose membership is composed of the leading commercial heat treating plants in the United States. The magazine is designed to be of interest to key management and operating personnel of heat treating establishments and to further the art and industry as well as to serve member companies with all news, reports of activities, technical information, etc.

♦

During its Annual Conference, Hotel Statler, New York City, the **Society for Advancement of Management** made the following awards:

Taylor Key: To Brehon Somervell (General U. S. Army, retired), chairman and president, Koppers Co. Inc. This award, named after Frederick W. Taylor, pioneer in the field of scientific management, is the highest conferred by American management. General Somervell's career is highlighted by his work in introducing engineering techniques to public administration and military services.

Human Relations Award: To Robert Wood Johnson (Brig. Gen. U. S. Army, retired), chairman of the board, Johnson & Johnson. General Johnson was chosen because of his long time leadership in the recognition of human dignity in every phase of industrial operation.

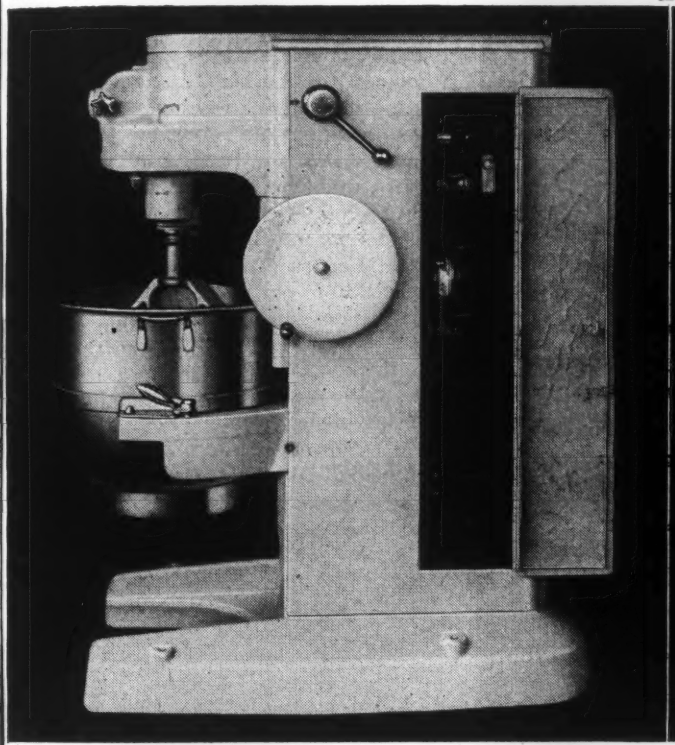
Gilbreth Medal: To Phil Carroll, industrial engineer, Maplewood, N. J. The engineer was honored for his outstanding contributions to work measurement in the field of industrial engineering. His textbooks on management controls, work standards and cost practices have contributed to the improvement of industrial working conditions.

♦

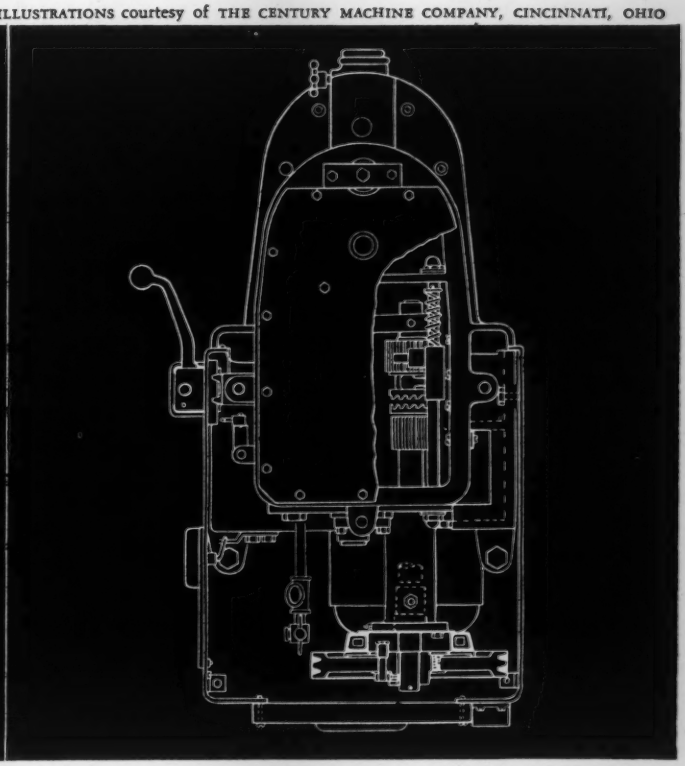
Public recognition to the three men principally responsible for the development of the Freon family of refrigerants was made by the **American Society of Refrigerating Engineers** during its 46th Annual Meeting, New York City, December 3-6. A "Certificate of Recognition" was presented to Thomas Midgley Jr., posthumously, and to Dr. Albert L. Henne and Robert R. McNary. C. F. Kettering, vice president and research consultant of General Motors Corporation who instigated the research that led to the discovery of Freon-12 as a safe refrigerant, made the awards.

How A Warner "ICB" Unit Simplifies Control on a *Century* Vertical Dough Mixer

ILLUSTRATIONS courtesy of THE CENTURY MACHINE COMPANY, CINCINNATI, OHIO



Side view of vertical dough mixer. Note position of Warner "ICB" Electric Brake Unit next to drive sheave (top right) and single control lever (top center).



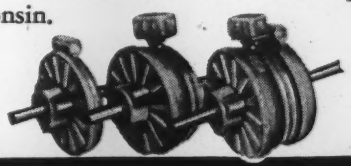
Top view drawing of dough mixer showing Warner "ICB" Brake Unit mounted on drive shaft next to sheave.

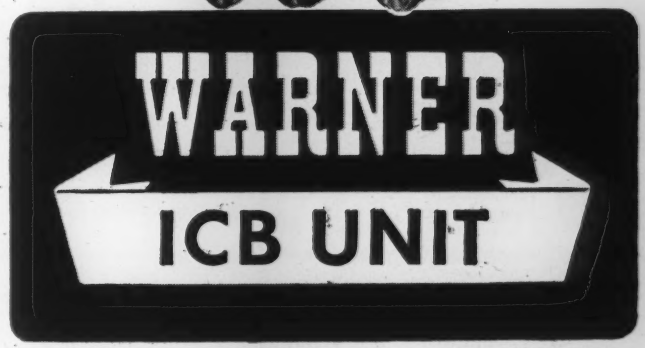
What Century says About the WARNER "ICB" Unit

Using a Warner "ICB" Unit on the Century Vertical Dough Mixer gives extremely simple quick-acting control. It enables us to make a single lever do the complete job of starting, stopping and speed selection.

It also enables the use of positive tooth clutches without clashing when changing speeds. The operator has complete shifting control because the single lever simultaneously de-energizes the motor, energizes the Warner "ICB" Brake and disengages the clutch. Moving the lever to the desired speed position mechanically places the clutch teeth in position to engage. Release of lever simultaneously releases the Warner "ICB" Brake, energizes the motor and engages the clutch.

Warner "ICB" Units are electrically-powered, low-wattage clutches and brakes. They can be operated singly or in combination—automatically or by push-button control. Because they are electric—they give lightning-fast response. Because they are compact and simple, they provide easy installation and long-term dependable operation. They're a new answer to a wide variety of old machine design and operation problems. For further information on how Warner "ICB" Units may help you — write today to the WARNER ELECTRIC BRAKE & CLUTCH CO., Dept. MD, Beloit, Wisconsin.





Warner ICB Units are manufactured by Warner Electric Brake & Clutch Co. — pioneers in the field of electric brake design and application since 1927.

SPECIFY:

PARKER O-RINGS

AN 6227 and AN 6230 Hydraulic O-Rings
Highest Grade Industrial O-Rings
AF 934 Fuel Resistant O-Rings
AMS 7270 Fuel Service O-Rings
AMS 7274 Oil Service O-Rings
AN 6290 Fitting Gaskets
Special Service O-Rings

ONLY Parker makes them ALL

. . . and all Parker O-Rings fully meet requirements of applicable specifications

Parker is the one O-Ring manufacturer having an all-inclusive line. And ONLY Parker has:

- most complete mold-making facilities
- most thorough compound formulation
- most extensive research facilities
- strictest quality-control processes
- most exacting inspection and handling

Popularly used O-Rings stocked by authorized distributors in principal cities. Special Service O-Rings of tested and approved compounds supplied on order. Write now for new Parker Catalog 903 which includes complete basic data on O-Ring sealing.

THE PARKER APPLIANCE COMPANY
17325 EUCLID AVENUE, CLEVELAND 12, OHIO
5827 W. CENTURY BLVD., LOS ANGELES 43, CAL.

Parker
TUBE FITTINGS
VALVES · O-RINGS

The PARKER Appliance Company
Cleveland 12, Ohio

Please send me my free copy of new O-Ring Catalog No. 903.

Name_____

Company_____

Address_____

City_____ State_____

SALES AND SERVICE PERSONNEL

NEWLY APPOINTED general sales manager for Carpenter Steel Co., Reading, Pa., is **H. Sturgis Potter.** He succeeds R. V. Mann, who until his recent death was vice president in charge of sales. Beginning his association with Carpenter in 1936 as sales engineer in the Indianapolis territory, Mr. Potter advanced to assistant manager of tool steel sales in the Reading office, then was named manager of tool steel sales, and in 1948 was appointed sales manager in charge of Reading mill products. His new position extends his responsibilities to the entire domestic and foreign sales organization for distribution of products from the Reading plant.

◆

B. W. Westcott has been elected vice president of Howell Electric Motors Co., Howell, Mich., and **James F. Murphy** has been appointed general sales manager. Mr. Murphy comes to Howell from the General Electric Co. and has a background of more than twenty years in the electrical and air conditioning fields.

◆

The Warner Electric Brake and Clutch Co. of Beloit, Wis., has announced the appointment of **Roger H. Brown,** Union, N. J., as eastern sales manager for the firm's ICB division. Mr. Brown formerly handled engineering sales of the company's industrial clutches and brakes in the New York area. Henceforth, New York sales will be handled by **R. C. Wiard** and **W. E. Gregg,** with headquarters at 101 South Main St., Middletown, Conn.

◆

Located in the company's main office at Sharon, Pa., **Louis K. Whitcomb** has been appointed manager of product development for Sharon Steel Corp. His duties in the newly created post will include the development of new applications for Sharon Steel products, end use products and customers' products. He will perform the same functions for Sharon's subsidiary companies. Before joining Sharon as a special representative in 1948, Mr. Whitcomb was connected with Great Lakes Steel Corp., Stran-Steel division, in Detroit as a regional sales manager and was also concerned with market development on Great

NEW PHOTOGRAPHIC MATERIALS . . .
NEW DRAFTING SHORT CUTS

Eliminate Costly Retracing

at INGERSOLL-RAND

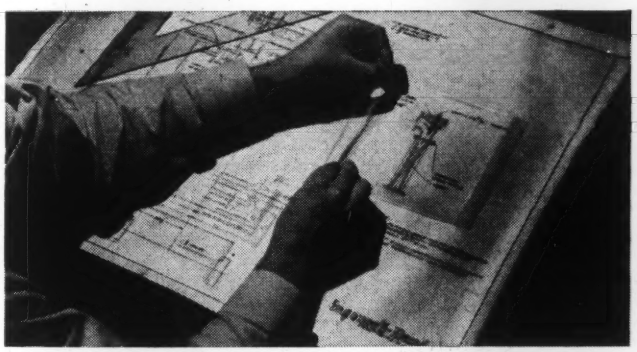
Phillipsburg, N. J.

"Ink quality" file copies of pencil drawings are produced with Kodagraph Autopositive Cloth

Instead of making expensive "ink on cloth" tracings of its original drawings, Ingersoll-Rand simply reproduces them on Kodagraph Autopositive Cloth. This new photographic material produces positive copies *directly* (like Kodagraph Autopositive Paper and Film) . . . without the negative step . . . without darkroom handling. No special equipment is required, either: a photocopy machine is used for the exposure operation . . . standard photographic solutions for development. *Result:* intermediates that have the sharpness, the sparkle of new ink tracings . . . with non-smudging, dense photographic black lines on a durable white cloth base.

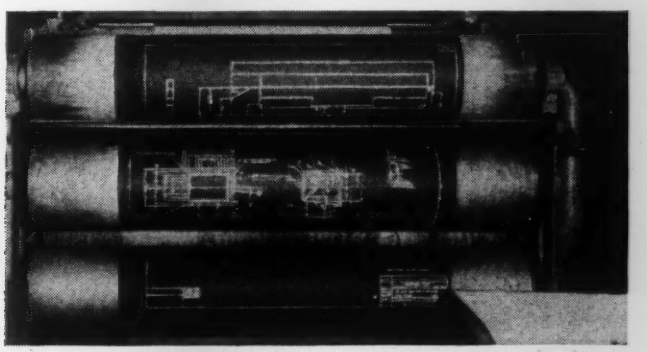
Old, soiled, or damaged drawings are restored with Kodagraph Autopositive Paper

When such drawings are taken from the files, the call is for Kodagraph Autopositive Paper—to eliminate hours of expensive retracing time. This low-cost, high-contrast photographic material increases line density . . . cleans up backgrounds . . . in many cases delivers serviceable intermediates that require no handwork at all. Drawings in very poor condition are restored by Ingersoll-Rand in the following manner: after an "Autopositive" is made, stains, creases, and other unwanted elements are removed with eradicator fluid or razor blade. Then, the print is used to produce a second "Autopositive," which is touched up with pencil if necessary.



Standard units are added to new drawings with Kodagraph Autopositive Film

Among the many ingenious drafting short cuts developed by Ingersoll-Rand is the use of Kodagraph Autopositive Film overlays made from standard-component drawings. These transparencies are kept on file . . . and taped to new drawings whenever necessary. Following this, the composite is reproduced on Autopositive Paper. *Result:* a photographic intermediate of uniform line density . . . plus important savings in drafting time.

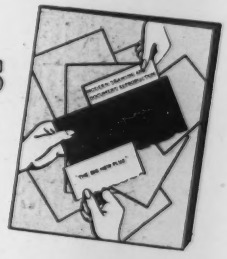


Additional advantages of using Kodagraph Autopositive intermediates

Sharper, cleaner blueprints are produced—at uniform, practical speeds—because Ingersoll-Rand makes them from "Autopositives" instead of its perishable original drawings. This way—there's far less chance of "reading errors" in the shop. And valuable originals are protected against machine wear and tear . . . constant handling; are kept safe in the files available for reference and revisions only.

Kodagraph Autopositive Materials

"The Big New Plus" in engineering drawing reproduction



MAIL COUPON FOR FREE BOOKLET

Learn in detail how you can use Kodagraph Autopositive Paper, Cloth, and Film — the revolutionary products which you, or your local blueprinter, can process quickly, economically. *Write today* for a free copy of "Modern Document and Drawing Reproduction."

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

19

Gentlemen: Please send me a copy of your illustrated booklet giving all the facts on Kodagraph Autopositive Materials.

Name_____ Position_____
(please print)

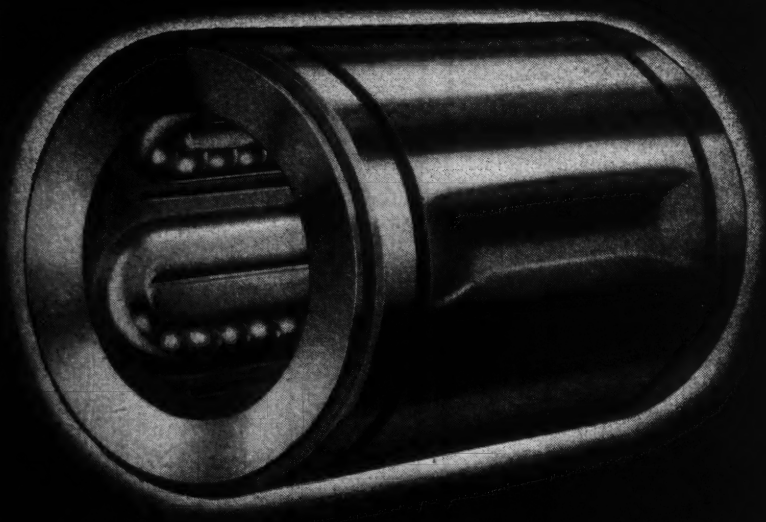
Company_____ Street_____

City_____ State_____

Kodak
TRADE-MARK

Announcing A New LOW COST Ball Bearing for Your

LINEAR MOTIONS



BALL BUSHING

THE COMMERCIAL GRADE SERIES B

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A Ball Bushing.

The low-cost Commercial Grade Series B bearing is now added to the Ball Bushing line and offered to original equipment manufacturers. This ball bearing has been developed for support of linear motions in competitively priced, volume produced products where super precision is not essential. Alert designers can now make tremendous improvements in their products by using Ball Bushings on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Competition is returning. Up-to-date engineering can be *important to you!*

- LOW FRICTION
- ELIMINATE BINDING AND CHATTER
- SOLVES SLIDING LUBRICATION PROBLEMS
- LASTING ALIGNMENT
- LOW MAINTENANCE
- LONG LIFE

NEW 1½" NOW AVAILABLE

Now in production for ¼", ½", ¾", 1" and 1½" shaft diameters. If you have a catalog, phone your representative or write us for new Data Sheet. If not, write for complete literature and the name of our representative in your city.

THOMSON INDUSTRIES, INC.

Dept. E 〉 *MANHASSET, NEW YORK*

PROGRESSIVE MANUFACTURERS USE BALL BUSHINGS— A MAJOR IMPROVEMENT AT A MINOR COST

Lake's Stran-Steel division products. Prior to this he was connected with Carnegie-Illinois Steel Co., first in Cleveland as a sales engineer, and later in market development work in Pittsburgh. He was in charge of all sales promotion work for end uses of steel pertaining to the building industry.

◆

Four new appointments were announced recently by the American Brake Shoe Co. **Fred P. Biggs** has been appointed president of the Brake Shoe and Castings division; **Stephen S. Conway** has been named vice president in charge of sales of the Brake Shoe and Castings and Southern Wheel division; **Ralph L. Robinson** has been made vice president of the Brake Shoe and Castings and Southern Wheel divisions; and **Edward R. Anderson** has become a vice president of the Brake Shoe and Castings division.

◆

Formerly vice president in charge of sales of Eagle Lock Co., Terryville, Conn., **Rollin B. Plumb** has joined Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y., in an executive capacity. He will play an important role in the company's sales organization, which has been greatly expanded to adequately service the demand for new product lines.

◆

In charge of tube sales to wholesalers and jobbers, **Buel A. Devine** has been appointed commodity sales manager for Wolverine Tube division of Calumet and Hecla Consolidated Copper Co. Inc.

◆

M. A. Moore, who has had engineering experience throughout the world, has been appointed sales and service representative for Double Seal Ring Co. of Fort Worth, Tex., in Maine, Vermont and New Hampshire. Mr. Moore comes to Double Seal from General Motors Corp., where he was supervisor of sales and service for General Motors diesel engines at Houston, Tex. His new headquarters are in Georgetown, Me.

◆

The Twin Disc Clutch Co., Racine, Wis., has announced the appointment of **Paul W. Wahler** as service manager and Robert A. Harmon as dealer sales supervisor. Both men will make their headquarters in Racine. Mr. Wahler first became associated with the company in 1937 as engineering assistant. In his new duties he will supervise all service operations through the five factory owned parts

We make them as if we were going to use them

Precisely controlled heat treating is just one of the steps taken at Accurate to assure adherence to your specifications.

. . . and it lowers *the overall cost of your springs*

HERE at Accurate we make springs the way we'd like to have them made for us if we were the user. We believe this guarantees you the best possible springs —uniformly RIGHT springs that permit maximum assembly rates and reduce the number of rejects due to faulty operation. It all adds up to lower manufacturing costs and better product performance for you.

Plan now to find out more about Accurate spring service and try Accurate on your next job. ACCURATE SPRING MFG. CO., 3813 W. Lake Street, Chicago 24, Ill.

Ask for your free copy of the new revised Accurate Handbook of Technical Data on Springs. This booklet has been out of print for some time and if you have previously asked for a copy and have not received it, we would appreciate your asking again.

Be sure the springs you buy are Accurate

Accurate Springs

Springs
Wire Forms
Stampings

AT LAST!
A Two-Way D. C. Poppet-Type Solenoid Valve *That's Engineered* to Meet Heavy-Duty..Constant Service Requirements

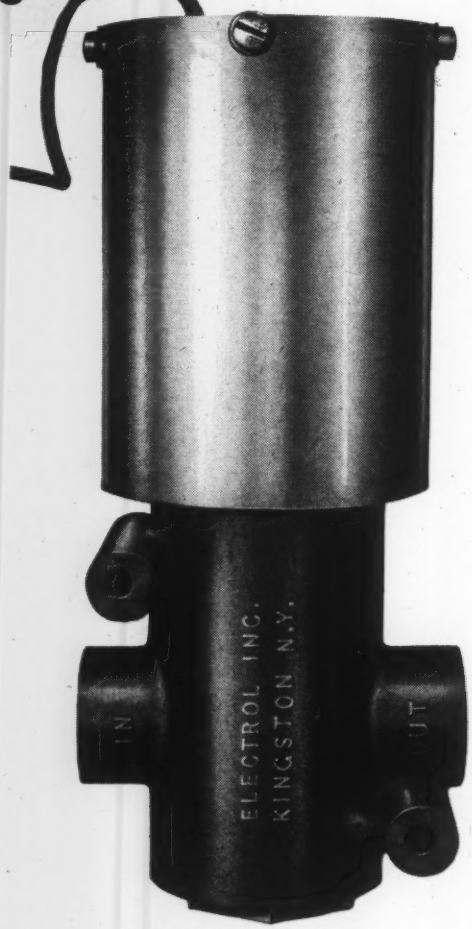
SIMPLE in design — and engineered to meet heavy-duty . . . constant service requirements —the new Electrol Two-Way D. C. Poppet-Type Solenoid Valve is winning wide acceptance among design engineers, who are aiming to improve a product and lower its operating cost.

It is available in either *normally open* or *normally closed* types, and can be used in oil, air or water, with pressures up to 1500 P.S.I. The Solenoid is designed to withstand constant energizing, and is obtainable in voltage increments ranging from 6 to 220-volts D. C.

The Valve is of the Poppet Type to assure an *absolute minimum of internal leakage*. It uses standard hydraulic packings, and has two ½" NPT ports, with a maximum rated flow of 5½ gallons per minute. Reducing bushings are supplied where NPT ports of ⅜", ¼", or ⅛" are required.

The Valve measures 8-3/32" x 3½" x 3", weighs approximately 10 lbs., and has two mounting bosses with holes which will accept ¼" bolts.

When ordering—specify maximum operating pressure, type of fluid used, voltage, port size, the flow required in gallons per minute, and whether the Valve is to be *normally open* or *normally closed*.



Our engineers will be glad to work with you in adapting this unit to meet your specific requirement—or on any problem involving the use of hydraulic devices.

Better Designed Products Use Electrol Hydraulics

Electrol
INCORPORATED
KINGSTON, NEW YORK
CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES
CHECK VALVES • RELIEF VALVES • HAND PUMPS
POWERPAKS • LANDING GEAR OLEOS • SOLENOID VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES
FOR BETTER HYDRAULIC DEVICES

stations which supply parts to all Twin Disc outlets. Mr. Harmon has been connected with sales engineering since joining the company more than three years ago.

♦

C. S. Allen has been appointed general manager of the Star-Kimble Motor division of Miehle Printing Press and Mfg. Co., Bloomfield, N. J. Mr. Allen comes to Star-Kimble from the A. O. Smith Electrical Mfg. Co. in Los Angeles, where he was vice president and general manager.

♦

Appointment of **Stuart H. Smith** as manager of industrial development and **John H. Tipton** as Cincinnati district manager of SKF Industries Inc. has been announced. At the same time, **Emerson D. Ogle,** manager of the industry division, was advanced to assistant district manager at Cincinnati and **B. K. Lathbury,** industry section supervisor, to assistant manager of industrial development.

♦

Cutler-Hammer Inc., Milwaukee, has appointed **R. A. Haworth** as manager of its Dallas, Tex., district sales office. Replacing Mr. Haworth, **M. C. Larson** has been named manager of the company's Baltimore sales office. This office will continue as part of the company's Philadelphia district sales office under **J. P. Simon,** manager.

♦

J. W. Greene, formerly sales manager of the company's New York branch, has been appointed to the newly created position of assistant manager of the valve and fitting department, Crane Co., Chicago. Mr. Greene is well qualified for this new responsibility as a result of twelve years of experience in the oil fields of the Southwest, ten years in the New York and eastern industrial markets and five years in the Midwest.

♦

In line with a general program of improving the facilities and strengthening the organization to meet continuing product demands, announcement has been made of the advancement of several sales executives of the DeVilbiss Co. of Toledo, O. **Emil F. Frey,** now in his thirty-fourth year with the sales organization of DeVilbiss, was promoted from his former post of assistant sales manager to director of sales promotion and advertising. Former assistant sales manager, **Henry M. Kidd** has become sales manager of spray equipment sales, having progressed

twenty typical GRAMIX® parts that save time, money and machining

—die pressed of powdered metal mixtures . . . oil impregnated for self-lubrication

79

THE UNITED STATES GRAPHITE COMPANY

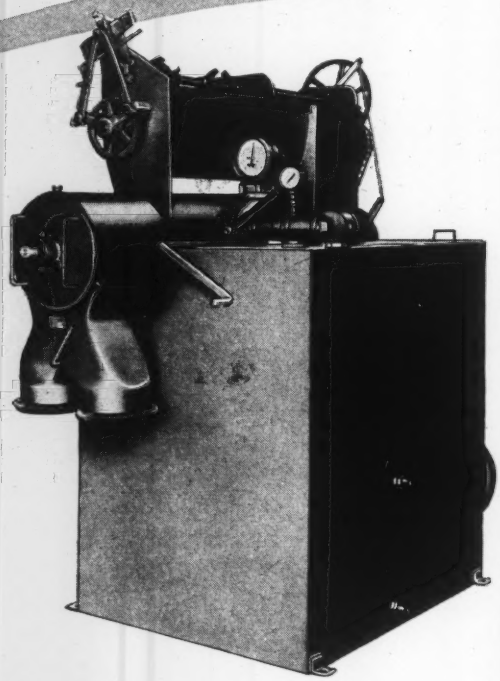
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

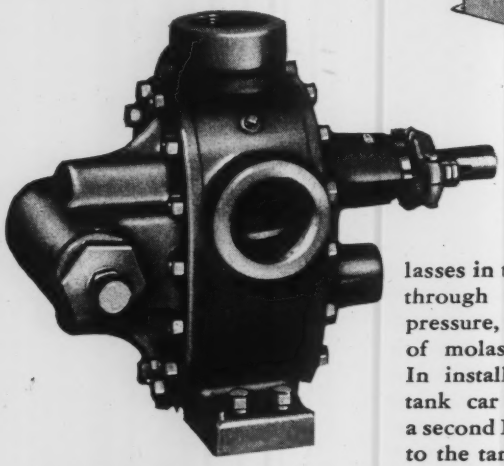
ROPER
Rotary
PUMPS

KEEP THICK, GOOEY MOLASSES MOVING IN...

WENGER FEED MIXERS

This unit, manufactured by Wenger Mixer Co., Sabetha, Kansas, is a compact, simply constructed mixer which blends thick, sticky, molasses with ground feed or hay. The tank holds 5100 lbs. of molasses. Capacity of mixer, 8,000 to 12,000 lbs. per hour, based on a mixture of 25% to 50% molasses.





A Roper 3600 Series Rotary Pump installed as standard equipment by Wenger is completely submerged in thick molasses when the mixer tank is full. Every 12 minutes molasses in the tank is completely circulated through this pump and by-pass under pressure, thus breaking down consistency of molasses to assure a better blend. In installations where a large tank or tank car is used for molasses storage, a second Roper serves to transfer molasses to the tank of the mixer.

This pump application is but one of many unusual installations . . . another tough job licked by Roper. Before you select a pump for either new installations or for replacement, investigate the Roper 3600 Series. Pressures to 60 p.s.i. — 40 to 200 g.p.m. sizes.

Write for complete information

SEE OUR CATALOG IN SWEET'S

GEO. D. ROPER CORP.
252 Blackhawk Park Ave.
ROCKFORD, ILLINOIS

ROPER
Rotary Pumps

through many steps in the sales division during his sixteen years with the company. Also, **John M. Ehni**, with twenty-eight years at DeVilbiss, has assumed the joint duties of export manager and branch plant coordinator.

♦

The Bridgeport Brass Co. has announced the appointment of **E. D. (Pat) Casseday** as its Houston, Tex., district sales manager to succeed **George Chatneuff.** Mr. Casseday was recently with Bridgeport's Los Angeles office and has been connected with the copper and brass industry for the past fifteen years, with experience in both the condenser and heat exchanger field. In his new position he will be responsible for the sale of all Bridgeport products in southeastern Texas.

♦

Edward A. Livingstone, vice president in charge of sales of the Babcock & Wilcox Tube Co., Beaver Falls, Pa., has been named to the Steel Products Industry Advisory Committee to advise in the administration of the Defense Production Act as it affects the iron and steel industry. This committee was established by the National Production Authority of the U. S. Department of Commerce.

♦

The Morse Chain Co., division of Borg-Warner Corp., Ithaca, N. Y., and Detroit, has announced the appointment of **Carlton R. Becker** as western factory representative. He will supervise the sales of Morse mechanical power transmission products in the eleven states west of and including Montana, Wyoming, Colorado and New Mexico. Mr. Becker's headquarters are at 1571 Harding Ave., Pasadena 7, Calif.

♦

The Hammel-Dahl Co., Providence, R. I., manufacturer of automatic control equipment, has announced the appointment of **John O. Tragard** as vice president in charge of sales and contracts. For twenty years Mr. Tragard was sales executive and legal counsel with the Foxboro Co., and for four years was employed with the Fulton Sylphon division of Robertshaw-Fulton Controls.

♦

Shannon C. Powers has been appointed general sales manager of Russell Electric Co., 4501 South Western Blvd., Chicago 9, Ill., a subsidiary of Raytheon Mfg. Co. Mr. Powers came to the sales department of Russell Electric Co. from the apparatus department of General Electric Co.

Another *cost-saving advantage* for users of

B&W

MECHANICAL

TUBING...

TAILOR-MADE

FORMABILITY

TO SATISFY ANY FABRICATION AND END-USE REQUIREMENTS

You have a wide choice of B&W MECHANICAL TUBING

TYPES—Seamless (hot finished, cold drawn or rocked.) Welded (from hot or cold rolled strip.)
GRADES—Carbon, Alloy, and Stainless Steels.
SIZES—Up to 9-5/8" O. D. in full range of wall thicknesses.
QUALITY—Open-hearth and electric furnace steels, including aircraft and magnaflux qualities.
CONDITION—Unannealed, annealed, tempered, normalized, or otherwise heat-treated as required.
SURFACE FINISHES—As rolled, as drawn, as welded, flash removed, turned, scale-free, and polished.
SHAPES—Round, square, rectangular, oval, streamlined, and special shapes.
FABRICATION—Upsetting, expanding, bending, safe-ending, and machining.

Illustration shows part hydraulically formed to precision tolerances from B&W Welded Stainless Croloy 16-13-3 Tubing (type 316). Concentric ends have same diameter and wall thickness of original tubing. Ask your B&W Tube Representative about your tube forming problems. He may help you uncover economies in selecting, ordering and fabricating.

B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX TUBE COMPANY
General Offices: Beaver Falls, Pa.
Plants: Alliance, Ohio, and Beaver Falls, Pa.
Sales Offices: Alliance, Ohio • Beaver Falls, Pa. • Boston 16, Mass.
Chicago 3, Ill. • Cleveland 14, Ohio • Denver 2, Colo. • Detroit 26, Mich.
Houston 2, Texas • Los Angeles 15, Calif. • New York 16, N. Y. • Philadelphia 2, Pa.
St. Louis 1, Mo. • San Francisco 3, Calif. • Syracuse 2, N. Y.
Toronto, Ontario • Tulsa 3, Okla. • Vancouver, British Columbia

GREER ACCUMULATOR
Eliminates 9 hrs. Machining Time
Saves $90 in Cost and 20% in Floor Space of Brosius Manipulator

Photo Courtesy of:
Edgar E. Brosius Co., Inc.
Pittsburgh 15, Pa.

The huge Manipulator shown here weighs 31,000 lbs. and handles steel billets or blanks up to 12,000 lbs. Yet it moves about with amazing agility. It draws or charges, tilts up or down, raises or lowers, rotates and moves from side to side with the ease of a light-weight and will bring to your forge shop added speed, safety and economy.

Mr. S. T. Morgan, Chief Engineer of the Brosius Company reports that by incorporating a Greer Accumulator in its design a saving of 9 hrs. of machining time, 1 hr. of assembly time, and a 20% of floor space was easily obtained. And in addition, the cost of the manipulator was cut $90.

This is but one of numerous applications where Greer Accumulators are reducing cost, improving efficiency and enhancing safety and economy of systems and machines using hydraulics for power transmission.

Our bulletin 300 describes in detail the construction and uses of Greer Accumulators. Write for your copy on your company letterhead today.

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

United States Patents Under Olear Licenses

GREER
HYDRAULICS INC.
454 EIGHTEENTH ST., BROOKLYN 15, N.Y.

YOUR SYMBOL OF SERVICE

SALES NOTES

TWO NEW appointments were recently announced by **Allis-Chalmers Mfg. Co.,** Milwaukee. The **Sales Engineering Co.,** 91 Glen St., Glens Falls, N. Y., is now a dealer for Allis-Chalmers motors and controls in Warren county, and the **Springfield Electric Service Co.,** 244 East Phelps, Springfield, Mo., has been named a certified service shop for Allis-Chalmers motors, controls and transformers in twenty southern and western Missouri counties and in five counties in northern Arkansas.

♦

The **Murray Equipment Co.,** 11820 Brush St., Detroit, Mich., has announced a distributorship agreement to handle **Worthington Pump and Machinery Corp.** Multi-V drives and fractional horsepower belts and sheaves. Murray Equipment Co. has supplied the greater Detroit area with chains, sprockets, tubing, hose and pulleys since 1946.

♦

Sales offices of the **Lapeer Mfg. Co.** have been moved from West Grand Blvd. to a new building at 1144 West Baltimore, Detroit 2, Mich. Manufacturing operations will continue at the company's plant located in Lapeer, Mich.

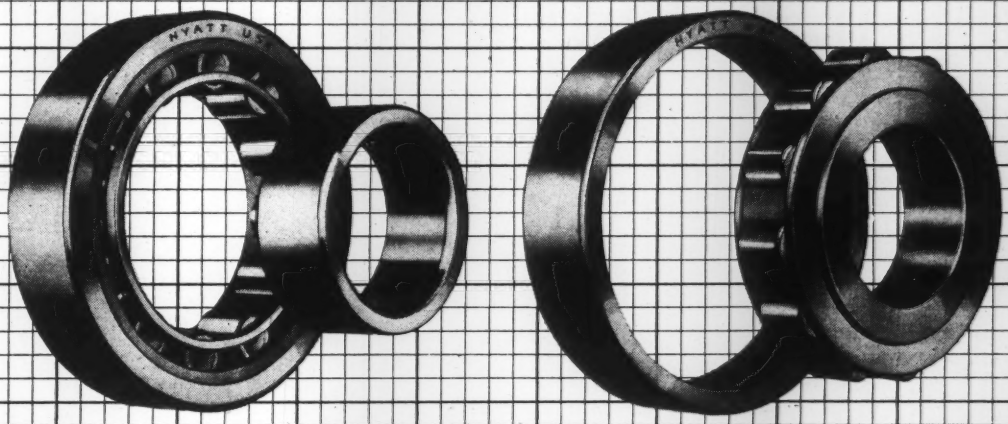
♦

Bogue Electric Mfg. Co. has announced the appointment of the **Karl Douglas Co.,** 835 West Olive St., Inglewood, Calif., as engineering and sales representative on the West Coast for 400-cycle motor-generator sets, d-c motor generators, regulated power supplies, sonic liquid-level gages for the aircraft and petroleum industries, magnetic amplifiers, voltage regulators as speed regulators, and a-c battery charging systems.

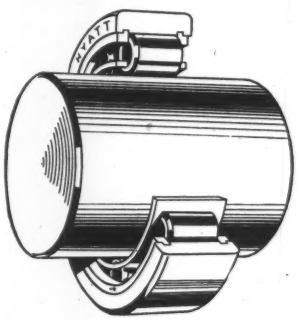
♦

An independent field sales organization has been set up by **Minneapolis-Honeywell Regulator Co.** for its valve division. The nucleus of the new organization will consist of regional sales managers and a staff of about twenty men who will concentrate on promoting the use of diaphragm control valves by instrument and original equipment manufacturers. The organization will provide national coverage. In addition, the com-

You have an option with HYATT HY-LOADS

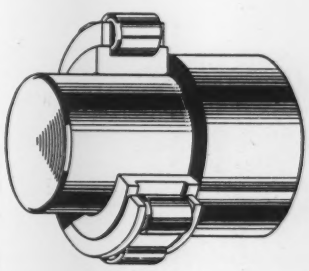


THE OPTION of omitted race operation with Hyatt Hy-Load Roller Bearings may simplify that new design you have on your drawing board.



When a shaft of larger diameter is needed for greater rigidity, or a bearing of smaller size is desired, the inner race of a separable inner race type Hyatt Hy-Load can be omitted and the rollers operated directly on a properly hardened and ground shaft.

When space is limited for the housing bore or a bearing of larger size is desired, the outer race of a separable outer race type Hyatt Hy-Load can be omitted and the rollers operated directly in a suitably hardened and ground bore.



This option you have is but one of the many features of Hyatt Hy-Loads. For complete information, write for Catalog 547, a complete engineering guide to radial bearing selection and use. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

OVER ONE HUNDRED YEARS OF CONTINUOUS SERVICE. ROUNDS, SQUARES, FLATS, HEXAGONS, OCTAGONS

BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS.

even tempered, but TOUGH!

HY-TEN "B" No. 3X

If you need even temper and toughness on heavy-duty parts, by all means investigate the unusual properties of HY-TEN "B" No. 3X!

WL can supply "B" No. 3X in bars, discs, flats or forgings heat treated to your exact hardness specifications. And this unusual HY-TEN alloy steel can be machined even when hardened as high as 477 Brinell (48 Rockwell "C")!

This unusual property—*machinability at high degrees of hardness*—makes this steel particularly well suited for parts which are apt to distort badly in the treating operation. This makes possible savings in handling and set-up time and finishing operations by putting parts into service without further treatment. A smoother finish is obtainable at almost any degree of heat-treated hardness than is possible with standard alloy steels.

WL *steels are metallurgically constant. This guarantees uniformity of chemistry, grain size, hardenability—thus eliminating costly changes in heat treating specifications.*

Write today for your FREE COPY of the Wheelock, Lovejoy Data Book, indicating your title and company identification. It contains complete technical information on grades, applications, physical properties, tests, heat treating, etc.

133 Sidney St., Cambridge 39, Mass.
and Cleveland • Chicago • Detroit
Hillside, N. J. • Buffalo • Cincinnati

WHEELOCK, LOVEJOY & CO., INC.

Warehouse Service

CAMBRIDGE · CLEVELAND
CHICAGO · HILLSIDE, N.J.
DETROIT · BUFFALO
CINCINNATI

In Canada
SANDERSON-NEWBOULD, LTD., MONTREAL

HY-TEN and AISI

pany will make use in some areas of field staffs now assigned to industrial, commercial and other products of various company divisions.

♦

The **Electric Products Co.** of Cleveland has appointed the **Power Equipment Co.** as representative in the western counties of Iowa and Missouri, the panhandle counties of Texas and the states of Arkansas, Oklahoma and Kansas. With offices in Kansas City, Mo., the Power Equipment Co. will handle all the industrial lines of the Electric Products Co.

♦

The **Hobsite Products Co. Inc.** of Paterson, N. J., manufacturer of Keldur, vibration isolation sheet material, has moved its principal offices to 308 Sussex St., Harrison, N. J., where greater facilities are available for service and customers' inquiries.

♦

Removal of its general sales office to 11 Commerce St., Newark 2, N. J., has been announced by **Volco Brass & Copper Co.** of Kenilworth, N. J. The move was designed to accommodate the expanded operations of the company, as well as to facilitate customer contact. Volco will continue to maintain administrative offices and mill operation in Kenilworth.

♦

The **Work-Factor Co.**, 366 Madison Ave., New York, N. Y., management consultants, has appointed the **Dill, Clitherow Co.** of Chicago as sales and service representative for clients in Illinois, Wisconsin and Indiana who use the Work-Factor system of time study in industrial production.

♦

The **Westcott Chuck Co.**, Oneida, N. Y., has appointed **John T. Everett & Co.**, 606 M & M Bldg., Memphis, Tenn., district representative of the company in Alabama, Arkansas, Oklahoma, Louisiana, Mississippi and Texas.

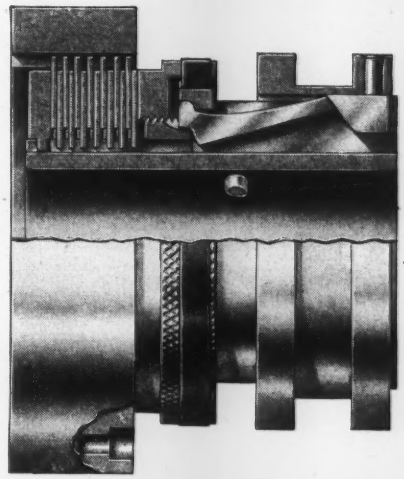
♦

The purchase of **Plastic Molders Inc.** of Chicago by **P. R. Mallory & Co. Inc.** has been announced. The company will henceforth be known as **P. R. Mallory Plastics Inc.**, 3670 Milwaukee Ave., Chicago 41, Ill. Facilities and operating personnel will remain unchanged in the company's production of compression and injection molded plastics.

♦

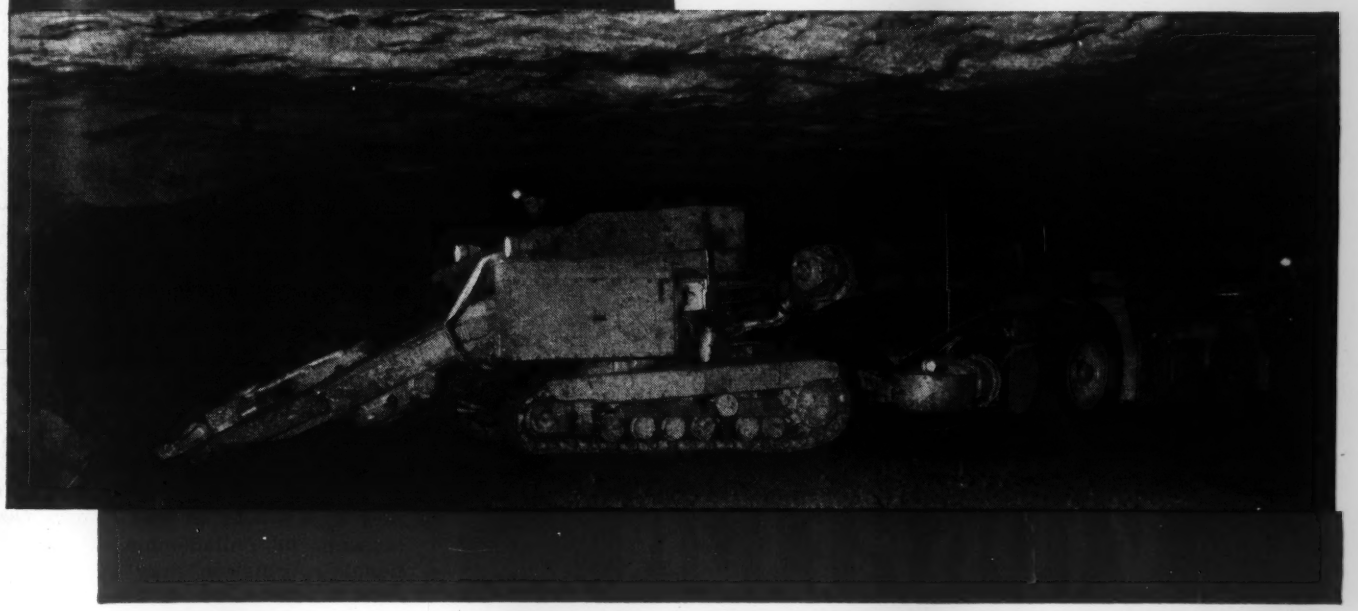
Pneu-trol Devices Inc., has moved to a new office and factory, 1436 North Keating, Chicago 51, Ill.

MAXITORQ



Keeps Good Company . . . .

in the MINING FIELD



We are pleased this month to pay tribute to the Joy Mfg. Co., Pittsburgh, Pa., for its remarkable 18-HR-2 Rock and Ore Loader . . . and to express our gratification for their selection of Maxitorq Clutches as original equipment.

Two double No. 27 Maxitorq floating disc Clutches . . . one for each crawler tread . . . control the power for independent forward and backward movement that permits precision maneuvering and positioning of the loader.

Only a ruggedly-built clutch can stand up under the tough going of this "battleship" machine that loads up to *12 tons of ore per minute.* Maxitorq is taking the job in its stride.

If you have a tough job requiring positive clutch action and long life . . . or an application calling for overload protection of a shear pin nature . . . ask our engineers for practical recommendations. Within its capacity (to 15 H.P. at 100 r.p.m.) there's no finer clutch made.

Send for Catalog No. MD12

8CJ50

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

"CIGAR, MARY?"

Just because Joe enjoys a good stogie, he shouldn't assume Mary enjoys one, too!

And just because one bearing is best lubricated by one particular grade of oil, you shouldn't assume that the same oil is best for *all* bearings on that machine. In many cases it isn't.

OIL CUPS permit you to lubricate each bearing with the oil best suited to that bearing—thus prolonging bearing life, reducing maintenance costs, cutting down-time, boosting production. And oil cups fortunately *cost very little.*

Gits oil cups have been the standard for industry for more than 40 years. Gits Bros. has the largest selection of oil cups available anywhere. Call on Gits Bros. for a prompt, efficient solution to your lubrication problems.

Write for free Price Guide Catalog

GITS BROS. MFG. CO.

1868 S. Kilbourn Ave. • Chicago 23, Ill.

VIBRATION TESTING

- Fatigue testing
- Location of noise
- Shake testing
- Identification of resonant frequencies
- Environmental tests for Armed Services specifications

UNITED STATES TESTING COMPANY, Inc.

Established 1880

HOBOKEN, NEW JERSEY

PHILADELPHIA • BOSTON • WOONSOCKET • MEMPHIS
CHICAGO • NEW YORK • LOS ANGELES • DENVER

Member of American Council of Commercial Laboratories

MEETINGS AND EXPOSITIONS

Jan. 8-12—

Society of Automotive Engineers. Annual meeting and engineering display to be held at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Jan. 15-18—

Plant Maintenance Show to be held in the Public Auditorium, Cleveland. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 18-20—

Society of Plastics Engineers. Seventh annual national technical conference to be held at the Hotel Statler, New York. Additional information may be obtained from society headquarters, 409 Security Bank Bldg., Athens, Ohio.

Jan. 22-26—

American Society of Heating and Ventilating Engineers. Tenth international heating and ventilating exposition to be held at the Commercial Museum in Philadelphia, Pa. Additional information may be obtained from the International Exposition Co., 480 Lexington Ave., New York, N. Y. Charles F. Roth is manager.

Jan. 22-26—

American Institute of Electrical Engineers. Winter meeting to be held at the Statler Hotel, New York. H. H. Henline, 33 West 39th St., New York 18, N. Y., is secretary.

Jan. 29-Feb.1—

Institute of the Aeronautical Sciences. Nineteenth annual meeting to be held at the Hotel Astor, New York. R. R. Dexter, 2 East 64th St., New York 21, N. Y., is secretary.

March 6-8—

Society of Automotive Engineers. Passenger car, body and materials meeting to be held at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

motors that add impressive Selling Points to the product — and please the End-User

- ☑ **100% TOTALLY ENCLOSED.** Baldor Streamcooled Motors are completely enclosed and fully protected against internal damage. They're dust-proof, drip-proof and vermin-proof.
- ☑ **COOL-RUNNING.** An outer-mounted fan forces cooling air over the entire exterior of the motor.
- ☑ **NON-CLOGGING.** These motors cannot inhale dust, dirt, lint or other contamination. There is no air-passageway to clog up and cause burnout or lowered efficiency. No dismantling for cleaning—no interruption of production.
- ☑ **QUIET, SMOOTH OPERATION.** Baldor Motors are of perfectly balanced design which assures quiet, smooth operation.
- ☑ **CLASS A or B INSULATION.** All Baldor Motors are of ball-bearing construction and are furnished with either Class A or B insulation.
- ☑ **INDIVIDUALLY TESTED.** Each motor receives a thorough commercial test before leaving the plant.
- ☑ **NATIONALLY SERVICED.** Baldor Motors are sold and serviced in more than 200 Trade Centers.

BALDOR ELECTRIC COMPANY

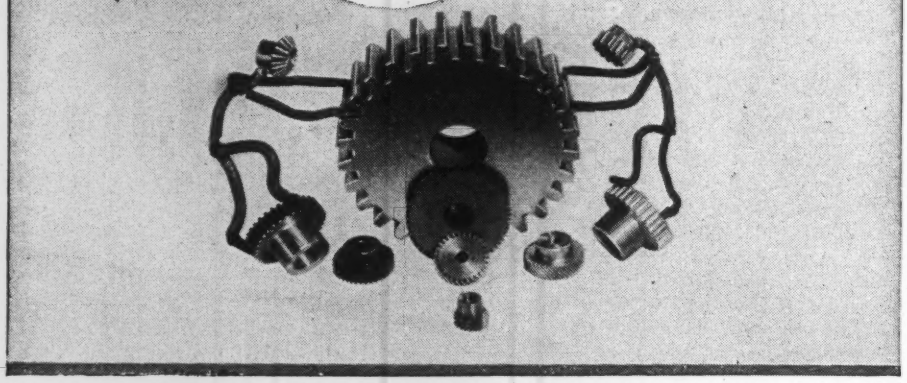
ST. LOUIS and other Principal Cities

Baldor **STREAMCOOLED MOTORS**

TRADE-MARK

MOTOR SPECIALISTS 29 YEARS

Mass. Gear



. . . for FAST SERVICE on All Types of MEDIUM AND SMALL SIZE GEARS

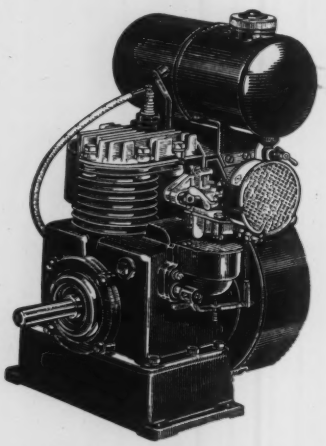
Many members of the Mass Gear organization have been with the company since its founding twenty-eight years ago. They have grown up with "Mass Gear" . . . . . in planning, producing, inspecting and shipping.

Their long-experience "know-how" has been concentrated on the interpretation of customer requirements and in meeting them intelligently and promptly.

•

If you have a gear problem, let Mass Gear help you. Write for a free catalog to Massachusetts Gear and Tool Company, Woburn, Mass.

Massachusetts Gear & Tool Co.



Model K7-1, 1½ H.P. 4-cycle, single cylinder, air-cooled. Length 13", width 14", height 17", Weight 38 lbs.

POWER FOR:

- Farm Equipment
- Garden Tractors
- Water Pumps
- Concrete Mixers
- Construction Equipment
- Conveyors
- Rollers
- Compressors
- Sprayers
- Motor Bikes
- Scooters
- And other uses.

Four-Cycle, Air-Cooled KOHLER ENGINES

Compact • Quick-Starting Reliable

Kohler Engines are designed, engineered and built to give the same dependable, economical service that has won world-wide acceptance for Kohler Electric Plants in construction and other industries. Made in several sizes, they are suited to a wide range of uses. Kohler engineers will gladly assist in working out applications for your particular requirements. Write for information. Kohler Co., Kohler, Wisconsin. Established 1873.

KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS • AIR-COOLED ENGINES

NEW MACHINES

And the Companies Behind Them

Domestic

VACUUM CLEANER: Medium-priced AVT-811 model tank type unit with throw-away dust and dirt collector bag. Controlled by foot switch. Finished in gray with chrome trim. Dimensions, 23 in. long, 7⅞ in. wide. Weight, 15 lb. *General Electric Co., Bridgeport, Conn.*

Heating and Ventilating

PORTABLE HUMIDIFIER: Evaporates ½ to 2½ pints of water per hour. Air output 12,000 cu ft per hour. Measures 14½ by 12½ by 11½ in., weighs 19 lb. *Kauffman Air Conditioning Co., St. Louis, Mo.*

ELECTRIC BATHROOM HEATERS: Heat by radiation and convection. Available in 1250 and 1500-watt sizes having 4266 and 5120 Btu per hour output ratings, respectively. Wall opening required, 17¾ in. high, 8¼ in. wide, 4 in. deep. *Westinghouse Electric Corp., Pittsburgh, Pa.*

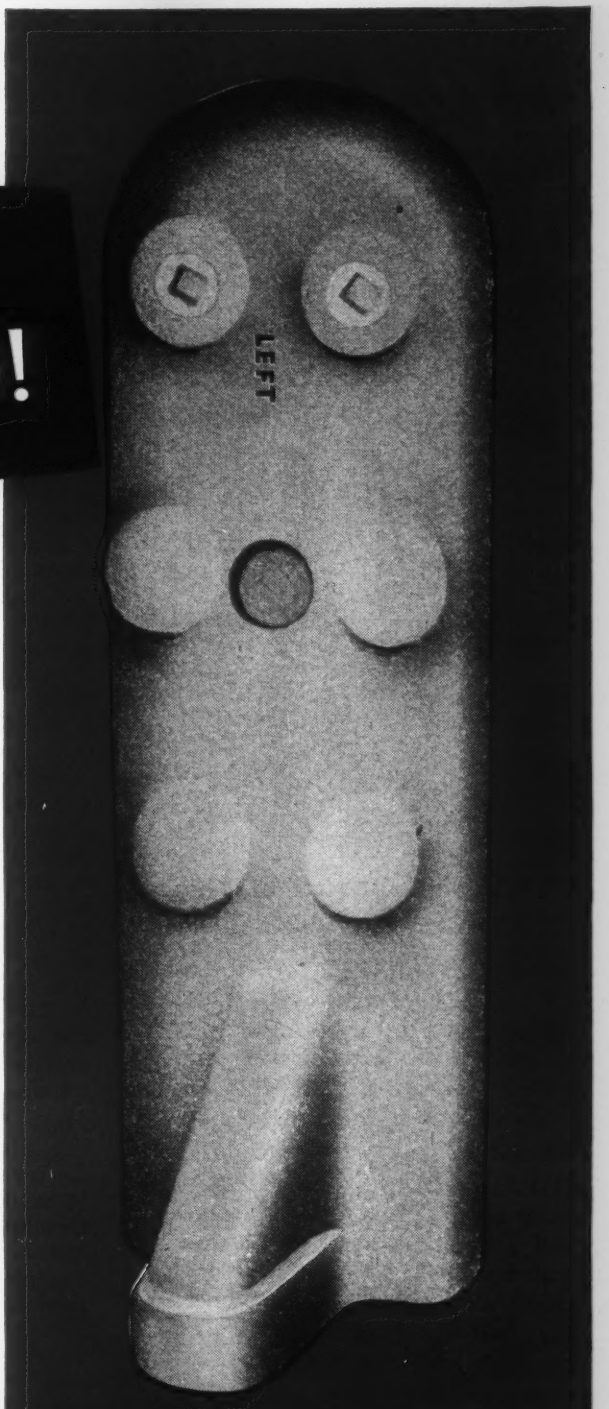
HEAT TRANSFER UNIT: For dissipating heat from power tubes or condensers in radio, television, radar, communications or other apparatus. Model 20-X unit dissipates to 15,000 watts by circulating cooling medium through system. Equipped with 6-bank reverse-flow radiator, squirrel-cage blower with 1400 cfm capacity, 3-stage centrifugal pump, expansion tank and necessary fittings. Enclosed in steel cabinet with choice of finishes. *Eastern Industries Inc., New Haven, Conn.*

Heat Treating

INDUSTRIAL CHILLING UNIT: Sub-Zero model R-120 for heavy duty at minus 120 F. Ten cu ft chilling chamber refrigerated by two units in cascade relationship. Has thermal capacity of 2000 Btu per hour at minus 120 F. For complete stabilization of metals, heat treatment of steel, shrink fit work, testing, etc. Chilling chamber measures 18 by 30 by 33 in. Insulated with 4 in. of Santocal. *Sub-Zero Products Div., Deepfreeze Distributing Corp., Cincinnati, O.*

SINTERING FURNACE: Molybdenum-vacuum furnace with max temperature 3300 F. Electric unit has neutral to reducing atmosphere pure enough to sinter chromium without oxidation. Steel case maintains 30-in. mercury vacuum. Tube has working area of 2 in. ID by 28 in.

THIS CASTING SAVED $12,000.00!



Why an Electrode Holder, redesigned by National Bearing Division, lasted over 73 times longer

A large Midwest plant was getting 5 days service from furnace electrode holders . . . before a trial order was placed with National Bearing Division. This plant saved dollars—*right from the start.* A special copper alloy permitted sound, dense castings at no sacrifice in electrical conductivity. Result? *30 days service—instead of 5—before replacement.*

On the next order, National Bearing Division engineers submitted a new design for the clamp—for greater strength and resistance to cracking. The redesigned electrode holders are still in use—after a year of trouble-free operation! They've saved $12,000.00 on replacement costs and furnace maintenance.

Better, longer-lasting non-ferrous parts can save money in your plant or product . . .

National Bearing Division has complete facilities for finding practical, economical solutions to non-ferrous bearing and casting problems. Investigate these complete facilities—whether your problem requires designed engineering service, or production of non-ferrous parts to your own specifications.

NBM

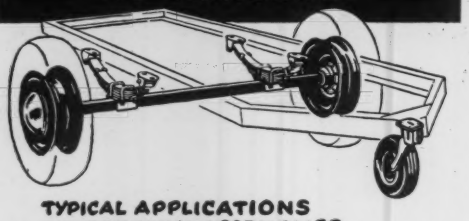
AMERICAN **Brake Shoe** COMPANY

NATIONAL BEARING DIVISION

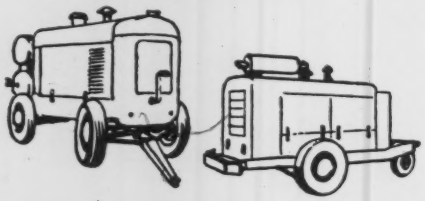
4931 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

UNITED
Caravan
AXLES
COMPLETE
PACKAGED
ASSEMBLIES



TYPICAL APPLICATIONS
OF CARAVAN ASSEMBLIES



CARAVAN AXLES SOLVE PORTABILITY PROBLEMS

NOW . . . UNITED offers you 2-wheel (single axle) or 4-wheel (front and rear axle) assemblies in complete kits to provide full spring mounted portability for a wide variety of industrial equipment.

CAPACITIES range from 1000 to more than 12,000 pounds. Brakes and Titanic automatic brake control optional. Retractable swivel caster wheel assembly is available for two-wheel units. Mounting brackets will be furnished for under or side-frame attachment.

UNITED has a complete line of equipment including SPECIAL AXLES (straight or drop) and stub spindles.

Let UNITED'S engineers solve your portable equipment problems. Write today for the new "CARAVAN AXLES" catalog or call Bedford 1323 for immediate service.

WRITE FOR CATALOG

THE UNITED MFG. COMPANY

1214 W. Interstate Street, Bedford, Ohio

long, with 18 in. controlled temperature length. Cylindrical furnace may be rotated for operation in horizontal or vertical position. Power input, 6 kw, 220 volt, 60 cycle, single phase. *Pereny Equipment Co., Columbus, O.*

Maintenance

PORTABLE STEAM CLEANER: Electric unit for cleaning machinery, equipment or facilities. Model JC-20 uses steam jet from built-in high-pressure boiler. Rated at 20 kw max, unit available for 220, 440 or 550-volt operation. Dimensions, 16 in. wide, 40 in. long. *Livingstone Engineering Co., Worcester, Mass.*

AIR HAMMER: For drilling, chipping, trimming, riveting, etc. Has no recoil or kick, operates only when in contact with work. Impact force adjustable. Measures 9½ in. overall with 1-in. diameter piston, requires 30 to 100 psi air supply. *Burgess Thomas Co., Bloomfield, N. J.*

Manufacturing

AUTOMATIC PRESSES: Wide-bed presses ranging from 30 to 2500 tons capacity. Include T-slots in top platen, remote control of variable-speed drive. Die clearance in 175-ton model, 28 in. front-to-back, 60 in. left-to-right. Roll feeds have 3-in. vertical adjustment, take material to 18 in. wide. Pitch adjustment of roll feeds, 0 to 12 in. Max stroke in 175-ton model, 10 in. Max speed, 250 strokes per minute depending on stroke length. *Brandes Press Co. Cleveland, O.*

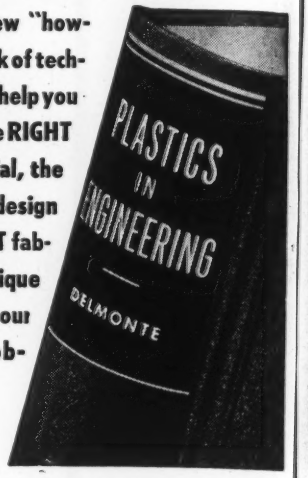
INJECTION MOLDER: For plastic injection molding of buttons, dentures, die tryout work, or other pieces to ¾-oz. Model HC-75 self-contained, uses hydraulic system for injection. Mechanical toggle clamp provides clamping pressure. Handles all thermoplastics, can be converted to nylon. Injects 0.44 cu in. material per second with ¾-in. diameter ram. Plasticizing capacity, 5.5 lb per hour. Max pressure on oil, 1200 psi; max pressure on material, 8600 lb. Mold size, 6 by 5 by 5 in., max casting area, 6 sq in. *Moslo Machinery Co., Cleveland, O.*

BENCH GRINDER: Portable Model 400 grinder uses two 4-in. diameter, ½-in. face vitrified grinding wheels. Has fan-cooled, 110-v, single-phase 3500-rpm motor and two adjustable tool rests. *Portable Electric Tools Inc., Chicago, Ill.*

INCLINABLE PRESS: Single-stroke No. 1½ press with 15-ton capacity. Open back model has 2-in. stroke standard, with up to 3-in. stroke available. Powered by ¾-hp, 1140-rpm motor through 160 rpm flywheel. Bolster area, 10 by 14⅜ in.; throat

INTERESTED IN PLASTICS?

This brand new "how-to-do-it" book of technical data will help you determine the RIGHT plastic material, the RIGHT mold design and the RIGHT fabricating technique to solve your plastics problem.



"Plastics in Engineering" by John Delmonte *is not an elementary text. It's an important working "tool" for everyday reference by designers, engineers and users of plastics.*

Written in the language of men who use plastics in design and production, "Plastics in Engineering" is one of the most valuable additions you can make to your technical library.

You'll find it a veritable gold mine of engineering data on methods of fabrication, the advantages and limitations of various materials and the chemical and physical characteristics of plastics.

You'll have scores of up-to-the-minute facts about plastics right at your fingertips: How strong various plastics are—for what uses they are best suited—how to design plastic parts—how these remarkable synthetic materials are molded, extruded, laminated, cast—how much heat they will stand—how to guard against failure—how to machine plastics and other vital factors that are so essential to satisfactory plastics performance.

Over six-hundred pages, fully illustrated with photographs, detailed drawings and tables, cover every phase of the plastics industry from raw material to finished product. From its first chapter which dips into the intriguing history and development of the plastics industry, to the last chapter which reveals the primary cost factors in producing plastics, it covers its field thoroughly and authentically.

PLASTICS IN ENGINEERING
(Completely Revised Third Edition)
by John Delmonte
Technical Director, Plastic Industries' Technical Institute

SEND FOR YOUR COPY TODAY

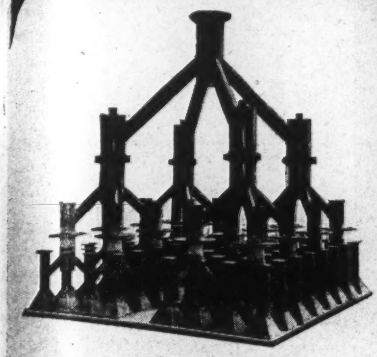
THE PENTON PUBLISHING COMPANY, MD-9-50
Book Department
1213 West Third St., Cleveland 13, Ohio

Send me a copy of "Plastics in Engineering" by John Delmonte.

☐ On ten days trial for free examination, following which I will either pay for the book at $10. plus postage, or return it in good condition.
☐ C.O.D.
☐ Remittance enclosed* in which case the book will be sent postpaid.

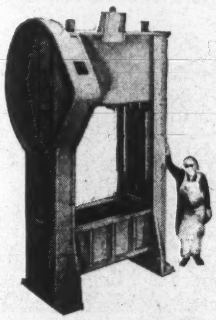
SIGNED: ..... TITLE: .....
COMPANY: .....
ADDRESS: .....
CITY: ..... ZONE .... STATE ....
*On orders for delivery in Ohio please add 30c to cover state sales tax.

Steel-Weld FABRICATION

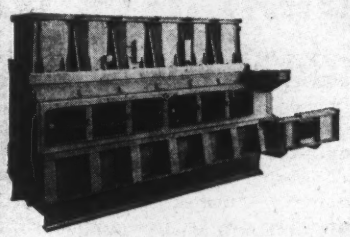


One of Several Parts of a Catalytic Cracking Plant Produced for the Petroleum Industry.

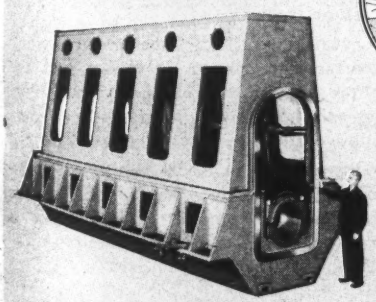
Pressure Vessels for the Chemical and Allied Industries.



Heavy Press and Machine Frames and Bases for the Machine Tool Industry.



Diesel Engine Crank Cases and Frames for the Marine and Electro-Motive Field.



Crank Cases, Frames, and other Parts for Manufacturers of Marine Steam Engines of Uniflow or Multiple Expansion Type.

A Steel-Weld Fabricated Gear Housing produced and completely machined ready for assembly by the Steel-Weld Division of The R. C. Mahon Company.

More and more designers are taking advantage of the many savings made possible by today's advanced technique in Steel-Weld Fabrication . . . thousands of heavy machinery parts and major assemblies are now produced in this form for manufacturers in many fields. If you can use Steel-Weld Fabrication to advantage, you will find in the Mahon Company an unusual source for welded steel in any form . . . a source with complete, modern fabricating and machining facilities backed by a staff of design engineers and craftsmen from whom you may expect a smoother, finer appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

depth, 5½ in.; bolster to slide distance, 6¾ in. Weighs 1100 lb, less motor. *Sales Service Machine Tool Co., St. Paul, Minn.*

VOLTAGE REGULATORS: Redesigned MLT 32-step regulators providing three-phase regulation in ⅝-per cent steps. Ratings increased to include 2500-kva, 69,000-volt size. Includes new voltage regulating relay which is permanently adjusted at factory, line-drop compensator with continuously variable resistance and reactance components, and relay adjusting rheostat. *Transformer and Allied Products Div., General Electric Co., Schenectady, N. Y.*

BENCH GRINDER: For grinding and lapping with silicon carbide or diamond abrasive wheels. Features 1-hp reversible motor, 12 gph impeller type coolant pump, swiveling wheel guard, three-position table to provide for wheel wear, milled protractor slot, and coolant filter. *Wickman Manufacturing Co., Detroit, Mich.*

METAL CUTTING SAW: Will also perform milling and planing operations such as slotting, removing corners of die blocks, etc. Machine raises and lowers hydraulically. Capacity, 14 by 18 in.; clearance under blade, 20 in.; cutting speeds, 60, 90 and 120 fpm. Vise swivels 45 degrees in either direction. Stock stop automatically moves out and up at end of cut to eliminate binding of blade. Automatic vise control available to eliminate hand tightening and loosening of vise when duplicate cuts are to be made. *W. F. Wells & Sons, Three Rivers, Mich.*

TABLETTING PRESS: For molding tablets and cakes or for pressing of ceramic and powder metal parts to 1¼ in. diameter. Model F-4 press applies 4 tons pressure from above and below. Production rate, 50 per minute. Speed adjustable by handwheel while press is running. Adjustment for change in part thickness made by controls at front of press. *F. J. Stokes Machine Co., Philadelphia, Pa.*

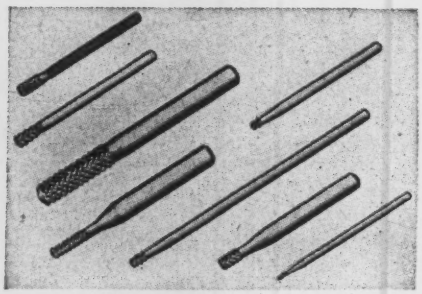
LINE BORING MACHINE: For simultaneous boring of crankshaft and camshaft bearings in automotive engine blocks. Operator loads blocks in machine, presses cycle start button, and removes blocks after boring. Production capacity, 25 to 35 blocks per hr. *Ex-Cell-O Corp., Detroit, Mich.*

BENCH GRINDERS: Line of four grinders for garages, repair shops, metal working plants, etc. Line includes: 6-in., close coupled, ¼-hp model with ½-in. wide wheel; 6-in. long end bell, ¼-hp model with ¾-

IT COSTS LESS

to have your precision metal parts made by

TORRINGTON



Special equipment and volume production enable us to save for you on a wide variety of precision parts made to order.

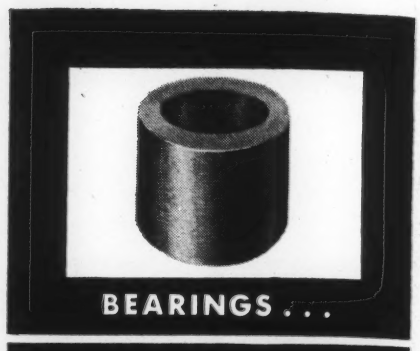
Typical are mandrels or spindles for mounted grinding wheels, abrasive points, felt wheels. Shank diameters to .500", close tolerances, centerless ground if desired. Chuck ends rounded, no burrs. Sharp, clear uniform knurls. Concentric tapers. Mandrels accurately hand-straightened.

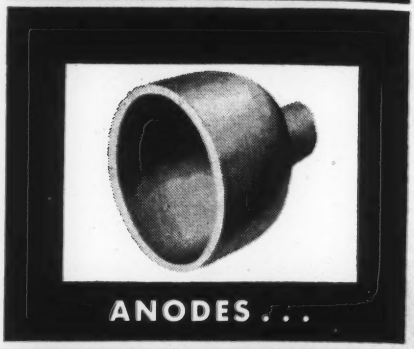
We are also set up to make for you such parts as special rollers, studs, dowel pins, screw driver and ice pick blades, surgical and dental instruments, pen and pencil barrels, instrument shafts and pivots, special needles, etc.

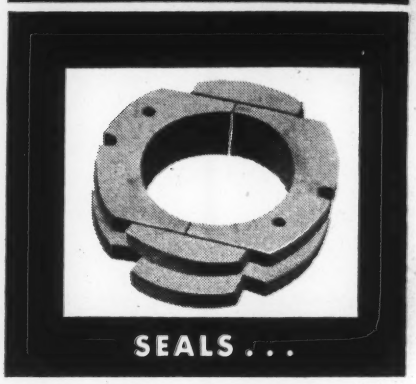
Send your prints and specifications today for a prompt quotation.

THE TORRINGTON COMPANY
Specialty Department
553 Field Street • Torrington, Conn.

Makers of
TORRINGTON NEEDLE BEARINGS







GRAPHITE'S ideal for each

Faced with a difficult parts problem? Graphite may be your answer. Graphite won't warp — offers highest thermal emissivity — makes better anodes. It resists excessive friction and needs no lubrication — two valuable bearing requirements. It withstands superheated steam without leakage, thus making an excellent seal.

Versatile graphite has many other important properties. It is not wet by molten metal . . . stands up to corrosion . . . can be molded, extruded, or machined easily. Its cost is *relatively low!*

Dependable carbon and graphite products have been made by Speer for more than 50 years. If you have a "problem part," consult Speer. No obligation.

Speer
CARBON COMPANY
ST. MARYS, PENNA.

ROCKRITE TUBING

Has High Surface Finish

BEFORE MACHINING!

PROVED BY PROFILOMETER RATINGS AS LOW AS 5 MICROINCHES

You can trim machining costs of ring shaped and cylindrical parts with Rockrite Tubing because it reaches your plant with close tolerances and smooth surfaces. The reason? This tubing is sized by a distinctively different process:

- **Dies compress the metal against a mandrel, tending to iron out small irregularities on both the inside and outside surfaces. The metal flows from high spots in the same manner as when it is forged.**
- **A certain amount of planishing action also takes place on the inside surface of the tube as it elongates under the pressure of the dies and creeps forward while in contact with the mandrel.**
- **In no part of this operation is there any action which can produce longitudinal scratches. The metal is not drawn through a die and over a mandrel.**

The proof of high surface finish? Profilometer readings recently taken on samples of Rockrite Tubing exhibiting superior finish show a range of RMS values of 5 to 55 microinches. In the manufacture of parts such as hydraulic cylinders this superior finish means substantial cost-savings well worth investigating.

HOW DO YOU SCORE? Do you know the three requirements essential for tube accuracy and lower-cost machined parts? New bulletin tells answers . . . gives more facts and figures on close-tolerance Rockrite Tubing. Send for your copy today.

ROCKRITE saves more than any other tubing

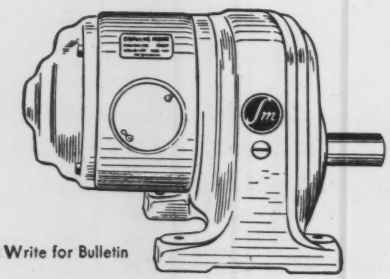
- **Higher cutting speeds**
- **Tools last longer between grinds**
- **Work-surface finishes are better**
- **Machined parts have closer tolerances**
- **Stations on automatics are often released for additional operations**
- **Extra-long pieces available—less downtime for magazine stocking and fewer scrap ends**
- **Closer tolerances often eliminate necessity for machining on outside or inside**

TR-119

ROCKRITE TUBING

TUBE REDUCING CORPORATION · WALLINGTON, NEW JERSEY

FRACTIONAL HORSE POWER
GEARS
INTERNAL,
HELICAL, SPUR
ELLIPTICAL, BEVEL
and WORM GEARS.
WORMS, RATCHETS
and SPROCKETS.
PRECISION
WITH
VOLUME PRODUCTION
Send for Bulletin
Rynel Corporation
301 MILLER ST. STERLING, ILLINOIS

The Key
to production
problems
Open the door to
greater production
with Sterling Slo-Speed
electric power drives.

Write for Bulletin
STERLING
ELECTRIC MOTORS
Plants: New York • Los Angeles • Hamilton, Canada
Offices in Principal Cities

in. wide wheel; 6-in., long end bell, 1/3-hp model using ¾-in. wide wheel; and 8-in., long end bell, ¾-hp model using 1-in. wide wheel. Wheel speed, 3440 rpm. *Cummins Portable Tools, Div. of Cummins Business Machines Corp., Chicago, Ill.*

DC WELDERS: Selenium rectifier welders with dual welding circuits. In 300/600 and 400/800-amp sizes. Dual circuits may be used independently or in parallel to provide single circuit of twice capacity. Parallel operation for max capacity obtained by bridle across secondary output terminals. *Westinghouse Electric Corp., Pittsburgh, Pa.*

SURFACE FINISHER: Special-purpose single-spindle machine equipped for mechanical or magnetic holding. For applications requiring precision grind operation such as pliers, wrenches, iron sole plates, springs, etc. Actuated by electro-hydraulic system, with 40-in. wide roll mounted on spindle. In and out stroke adjustable from 0 to 24 in. Max holding and working area, 24 by 38 in. Air circuit provides float of buff at predetermined uniform pressure. *Clair Manufacturing Co., Olean, N. Y.*

TRANSFORMER WELDER: Model MCX 200-amp arc welder for sheet metal and industrial jobs. Dimensions, 12 by 17 by 23 in. Three current ranges selected by tapered plug connectors. Infinite hand crank adjustments within each range provide 30 to 250 amp currents. Can use $\frac{1}{16}$ to $\frac{5}{16}$-in. diameter electrodes. Employs hot start control with hermetically-sealed gas-filled time-delay relay magnetic switch with no open contact. *Air Reduction Sales Co., New York, N. Y.*

VERTICAL MILLING AND DIESINKING MACHINE: Sensitive ¾-hp machine with 10 spindle speeds. Overall table dimensions, 25¼ by 9⅜ in., max spindle to table distance, 17¼ in. Headstock swivels 90 degrees. Provision made on headstock for installing tracer arm for duplicating work. Longitudinal hand movement of table, 12¾ in.; cross movement of table, 8 in.; vertical movement of table, 17¼ in., floor space required, 56 by 56 in.; net weight, 1650 lb. *DCMT Sales Corp., New York, N. Y.*

SPECIAL STITCH WELDER: For welding spouts to stainless coffee pots. Adaptable to permit spot spacing and electrode positioning on other curved surfaces with minor gear and cam alterations. Spot spacing, work indexing and electrode operation automatically controlled. Machine rated at 30 kva, welds 0.032-

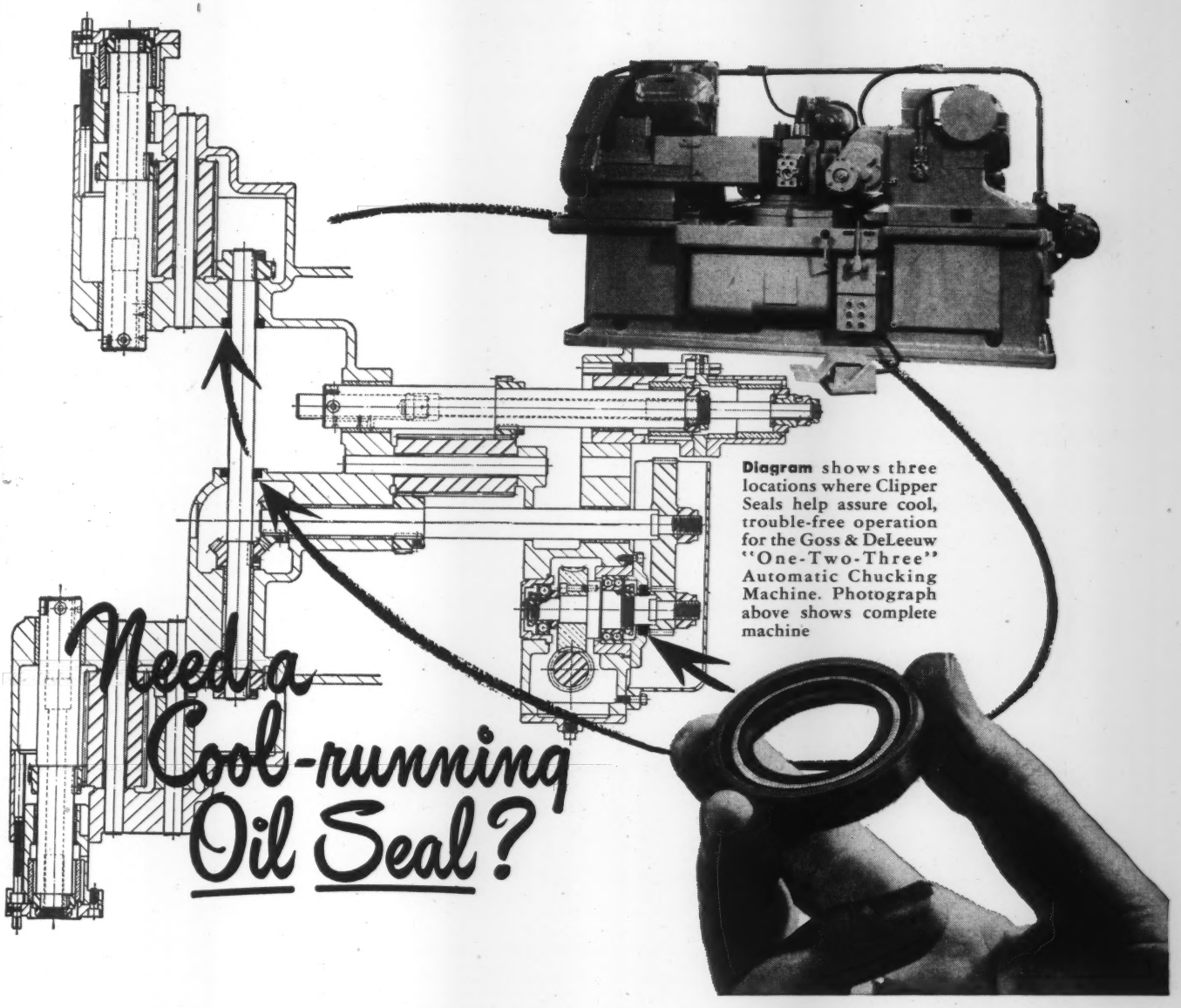


Diagram shows three locations where Clipper Seals help assure cool, trouble-free operation for the Goss & DeLeeuw "One-Two-Three" Automatic Chucking Machine. Photograph above shows complete machine

Need a Cool-running Oil Seal?

Goss & DeLeeuw turns to Clipper Seals

IF YOU'RE SEARCHING for an oil seal that you can depend on to run cool . . . thereby minimize friction and shaft wear, and last longer . . . you'll be interested in hearing why The Goss & DeLeeuw Machine Company selected Clipper Seals for their "One-Two-Three" Automatic Chucking Machine.

The "One-Two-Three"—a revolutionary contribution to the metal working field which permits machining three-faced parts in a single operation—required an oil seal that would minimize friction and wear at high shaft speeds. It would also have to do a highly efficient job of keeping lubricants in place.

After careful tests, Goss & DeLeeuw found that the simple design of the Clipper Seal decidedly reduces friction and wear . . . assuring cool, trouble-free operation plus a long service life. They found, too, that Clipper Seal's tough, dense heel gives the rigidity necessary for a press fit in the cavity . . . while the flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, provides effective sealing at all times.

The solution to *your* sealing problem may be this all-round efficiency of Clipper Seals. They come in a variety of precision-moulded designs . . . in sizes to fit shaft diameters from ¼" to 66", for temperatures to 450F, and for shaft speeds to 3500 rpm. Get complete information by writing for Brochure PK-46A. Address Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

SPEED PRODUCTION WITH

10-DAY DELIVERY

SPEED DESIGN WORK WITH

FREE TEMPLATES

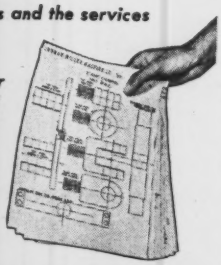
SAVE SPACE WITH

O-M CYLINDERS

Ortman-Miller cylinders for air, hydraulic and water applications are available in the full range from 1½" to 8" bores on *ten-day delivery!* Add this to the other advantages of space saving and simplicity of design (no tie-rods, no bulky end caps).

All body parts machined steel (not cast), all bearing surfaces bronze. Circumferential keys allow disassembly and repacking in a matter of minutes, or interchangeable mounting brackets may be fitted without disassembly. Parts adjustable to any angle.

Write today for details and the services of your distributor.



And... write today for free complete set of templates in one-half and full scales. Precision drawn to save your time, speed design work. Shows all O-M cylinders and all mounting devices.

ORTMAN-MILLER

MACHINE CO., INC.

1210 150th Street, Hammond, Indiana

in. to 0.022-in. 18-8 stainless at rate of 192 assemblies per hour at 80 per cent efficiency. *Taylor-Winfield Corp., Warren, O.*

TUBE BENDER: Makes up to 1000 bends per hour on 1-in. 16-gage steel tubing. Fully automatic die and clamping head grips and bends tube automatically. Handles round, square and rectangular tubing and pipe, light angles, channels, solid bars, etc. Interchangeable dies available for different size tubing diameters and radii. *Paul Machine Tool & Die Works, Chicago, Ill.*

BAND SAW BLADE WELDER: Handles new 0.050-in. diameter contour-cutting band saw blade and all types of blades to ½-in. flat. Particularly useful on internal tool and die work. Fully automatic unit has built-in grinder and gage for checking thickness of weld on flat saws. Overall dimensions, 7¾ by 12 by 7 in. *Brennen Manufacturing Co., Brooklyn, N. Y.*

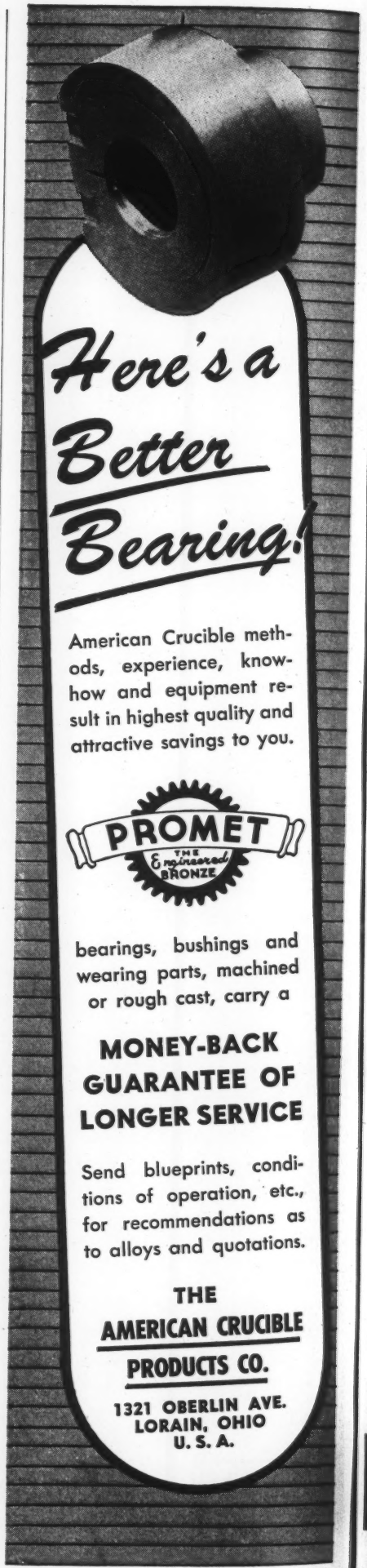
PRECISION GRINDER: Internal grinding attachment for lathes and other machine tools. Powered by standard type constant-speed, continuous-duty 1/6-hp 3450-rpm a-c motor. Motor belted through intermediate shaft to obtain quill spindle speed of 30,000 rpm. Drop in spindle speed when taking 0.003-in. cut in hardened steel, less than 1000 rpm. Four arbors permit grinding holes to 3⅞-in. deep max when using 1-in. wheel. *South Bend Lathe Works, South Bend, Ind.*

PUNCH PRESS: Capacity, 43 tons at bottom of stroke. For die cast trimming and light sheet jobs. In flywheel or geared types, with 21-in. opening through back of press. Powered by 3-hp motor. Includes 5 to 1 gearing ratio, back shaft with 230 strokes per minute speed, ram capable of 46 strokes per minute. Standard stroke, 11½ in. *Johnson Machine & Press Corp., Elkhart, Ind.*

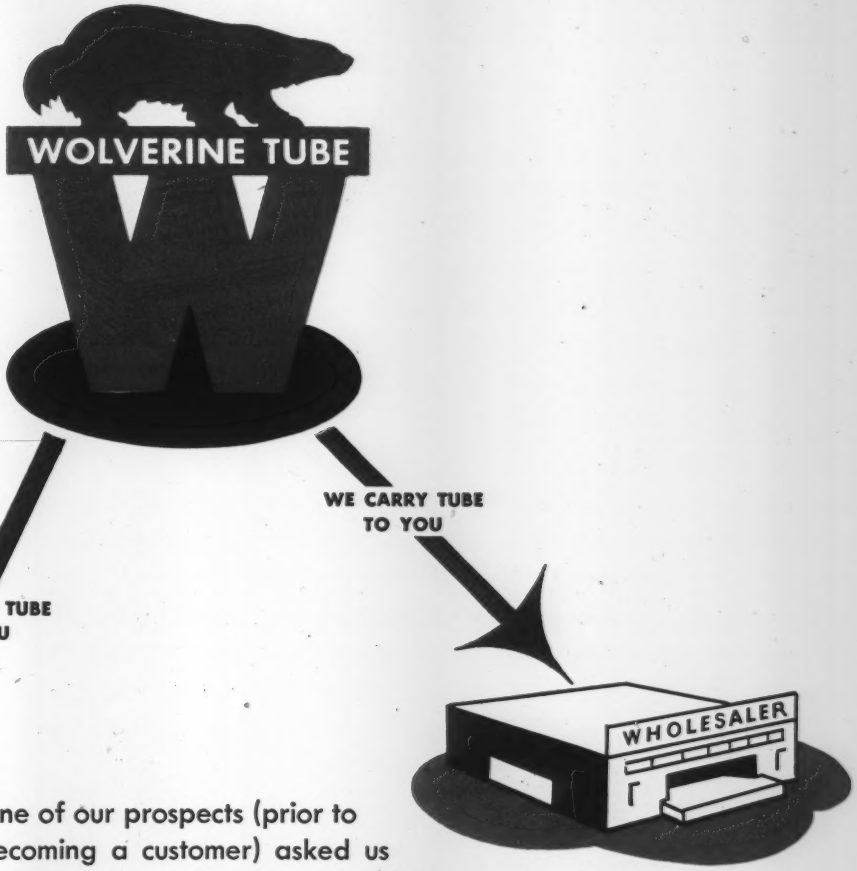
Materials Handling

FORK TRUCKS: Battery-powered trucks in 5000 and 6000 lb capacities. Width over drive wheels, 39¼ in.; outside turning radius, 79 in.; minimum intersecting aisles, 69 in.; right-angle turn, 98 in. plus length of load; overall height, 83 in.; telescoping lift, 126 in.; initial lift, 61 in.; wheelbase, 48 in. Lower capacity model weighs approximately 9500 lb; other model, 10,500 lb. *Baker Industrial Truck Div., The Baker-Raulang Co., Cleveland, O.*

LIFT-TRUCK: Battery-powered industrial truck with hinged platform which reduces platform length by about 50 per cent. Overall length with platform in load-carrying po-



We don't Sell Your Customers



One of our prospects (prior to becoming a customer) asked us whether we would sell tubing to him and also accept orders for tubing from *his* customers.

We shouted an emphatic "No!"

That question is often asked by those who select concerns to supply material as components of their finished products or for sale over their counters.

Over many years we have maintained a definite policy of *not* competing with our customers. We try to protect their interests for we sincerely appreciate the relationship we have with them.

As a customer, you can feel free to come to us for any help you need, knowing that your problems can be discussed with us in strict confidence.

If you're our customer, we like that. And we're not your competitor, so you like that.

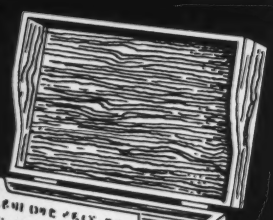
Let us be of help to you.

WOLVERINE TUBE DIVISION

Calumet & Hecla Consolidated Copper Company
INCORPORATED
MANUFACTURERS OF SEAMLESS, NON-FERROUS TUBING
1433 CENTRAL AVE. • DETROIT 9, MICHIGAN

PLANTS IN DETROIT AND DECATUR, ALA.
Sales Offices in Principal Cities

Here's Your INDEX to Titeflex



The ALL-METAL Flexible Tubing

REASONS WHY TITEFLEX CAN DO A BETTER JOB FOR YOU

METALS

Titeflex is constructed entirely from metal in brass, bronze, stainless, Monel and Inconel, to solve most problems of heat, pressure and abrasion.

SIZES

Regardless of the job, there's a size of Titeflex suitable. Inside diameters from 3/16 to 4" are standard. Other sizes available for special requirements.

TEMPERATURE & PRESSURE

Types and sizes of Titeflex are available for temperatures from minus 300°F to 1625°F, and pressures of several thousand pounds. Most corrosive liquids and gases can be handled by one of the various metals in which Titeflex is produced.

FLEXIBILITY

Where motion is present, the flexibility of Titeflex saves both time and money. It is extremely valuable for installations involving vibration, expansion, constant flexing, or stationary misalignment.

Because it's all-metal, Titeflex tubing has the inherent strength of metal, plus the advantage of flexibility. That's why Titeflex does a *better job* and *lasts longer.*

Write for complete catalog

Titeflex, Inc.

500 Frelinghuysen Avenue • Newark 5, New Jersey

TITEFLEX CAN FILL YOUR FLEXIBLE TUBING NEEDS TO A . . .

sition, 109 in.; with forward end of platform raised, 84 in. Capacity, 4000 lb; weight, 3670 lb; width, 38 in.; height of head frame, 83 in.; height of platform above floor in lowered position, 7 in.; max raised height, 59 in. *Elwell-Parker Electric Co., Cleveland, O.*

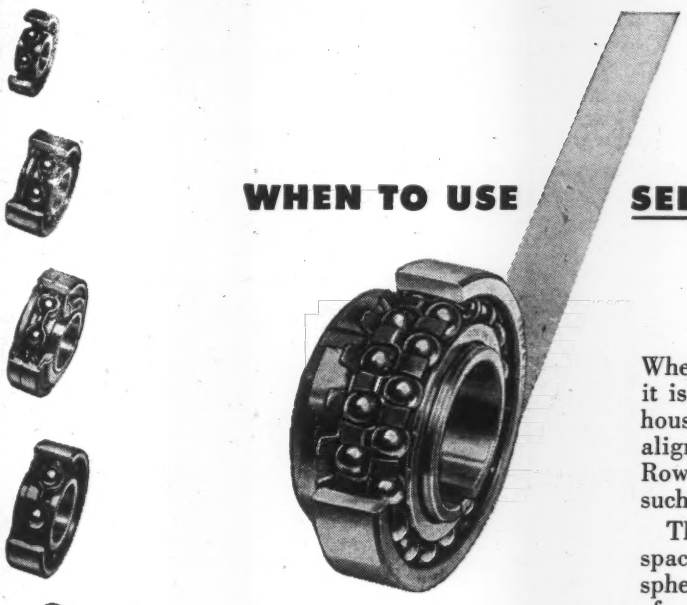
CHIP CONVEYOR: For continuous removal of chips, borings or turnings from automatic or multiple-spindle machines. Hinged steel conveyor belting will handle hot, heavy, wet or dry material. Models available to meet height and width requirements of all metal-removing machine tools. *May-Fran Engineering Inc., Cleveland, O.*

TRACTOR: For moving and spotting trailers around terminals and warehouses. Transmission, steering, fifth wheel elevator and winch all hydraulically operated. Has 8 speeds forward and reverse, can negotiate 8 per cent grade with 28,000-lb gvw at 6.7 mph or same grade with 160,000-lb gvw at 1.2 mph. Top speed, 10½ mph. Fifth wheel mechanism moves 18 in., can lift 40 tons. Winch powered directly from 100-hp tractor engine, has 16,000-lb capacity. Turning radius, 11½ ft. *Columbia Truck & Equipment Sales Inc., New York, N. Y.*

TRAMMER: Battery-powered, 1½-ton trammer for haulage work in metal mines having restricted clearances. In any gage track between 18 and 24 in. Length overall, 71½ in.; width, 35⅝ in.; weight with battery, 3000 lb; height with standard battery, 38⅛ in.; height with high type battery, 44⅛ in. Rated drawbar pull, 400 lb; max pull, 750 lb. Speed at rated pull, 2 mph; speed of locomotive alone, 7 mph. *General Electric Co., Schenectady, N. Y.*

POWER HAND TRUCKS: Two models with 6000 lb capacity. Battery-powered model has 1¼-hp electric motor mounted inside 14-in. drive wheel. Includes automatic acceleration, dynamic braking for smooth starting and stopping. Other model powered by gas engine driving hydraulic pump and motor. Hydraulic motor mounted inside drive wheel with output shaft driving through reduction to internal gear in wheel. *Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.*

ADJUSTABLE CONVEYOR: Combines standard length unit with extreme length unit, with 10 positions or adjustments available. In all standard belt widths, equipped with side rails if desired. Slide type Adjust-oveyors carry total distributed loads of 850 lb or net unit loads of 150 lb. Roller type units carry



WHEN TO USE SELF-ALIGNING DOUBLE ROW RADIAL BALL BEARINGS

Wherever shafts bend or deflect beyond the norm—where it is impossible to machine the housings in line, or when housings are mounted on separate structures and perfect alignment is impossible—Federal Self-Aligning Double Row Radial Ball Bearings meet the need for correcting such misalignment.

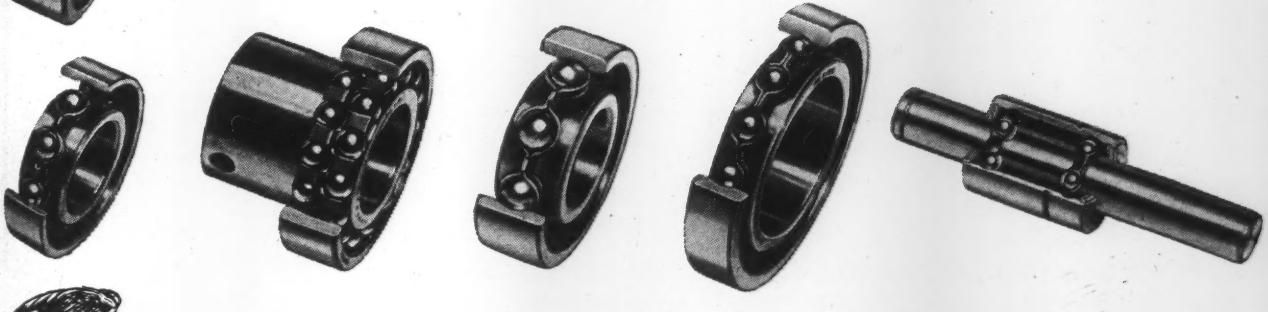
These versatile bearings are engineered so that the balls, spacer and inner ring always rotate *freely* within the spherical outer race at a considerable angle on either side of normal without binding or additional strain on the bearing parts. As a result, they are *quiet-running*, smooth-aligning and durable—solve problems which cannot be handled by ordinary radial bearings.

Federal Self-Aligning Double Row Radial Ball Bearings are made in light, extra-light, medium and heavy series; in regular and wide types for any load requirement; and in adapter and wide inner ring types for securing at any point along a plain or shoulderless shaft.

They're all described in our catalog "K," which covers the complete Federal line . . . every type and size, shielded and sealed . . . for every anti-friction need. (A few of the many types are shown here.) You'll also find ball bearing selection charts to help you compute bearing loads, determine capacities at every speed, and select the type and size ball bearing best suited to your application. Write today for your copy of this 260-page catalog. Also write for a copy of our latest Ball Bearing Conversion Tables which contain complete up-to-date interchange information.

THE FEDERAL BEARINGS CO., INC. · POUGHKEEPSIE, N. Y.

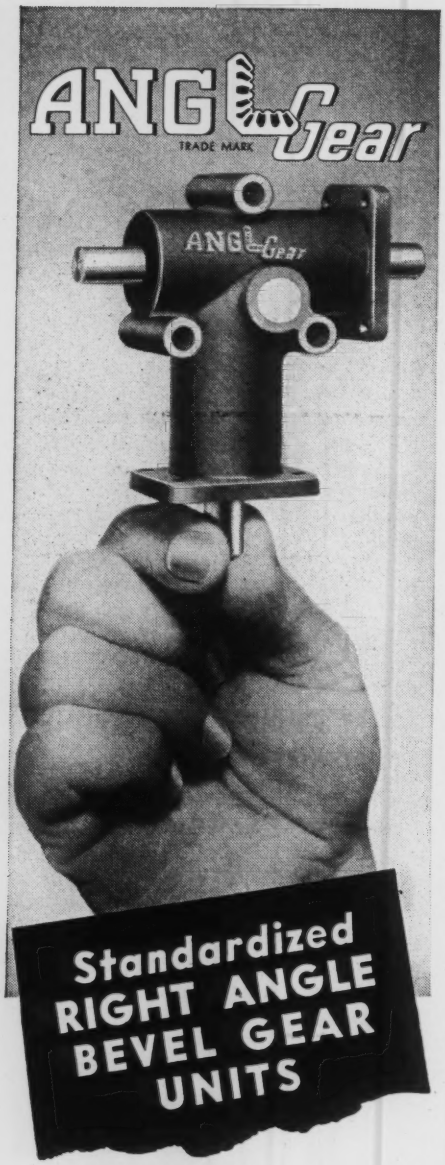
Makers of Fine Ball Bearings



FEDERAL BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

Quality since 1908



Standardized RIGHT ANGLE BEVEL GEAR UNITS

With Capacity of Units Many Times Their Size and Weight

Suitable for use in either manual or power operated systems beyond the limitations of ordinary commercial products. Two basic models meet the requirements of virtually all industrial applications. 1:1 or 2:1 ratio with either 2 or 3 shaft extensions.

AIRBORNE
ACCESSORIES CORPORATION
25 MONTGOMERY ST. • HILLSIDE 5, N. J.
SOLD THRU LEADING DISTRIBUTORS

heavier loads. Standard lengths vary from 8 ft closed/14½ ft open to 32 closed/55½ ft open. *Stewart-Glapat Corp., Zanesville, O.*

Service Equipment

LUBRICANT PUMPS: Three models of air-operated, high-pressure pumps for delivering lubricant from 25, 35 or 50-lb original containers. New sealed-in air motor has air valve and related parts located between air cylinder and pump tube. Model 711 mounted on 20½-in. square base with casters, stands 31¾ in. high, 17½ in. in diameter. Model 711-A mounted on pivot-swing dolly with semipneumatic tires and pulling handle. Model 711-B stationary without dolly or base. Pumps deliver 14½ oz of chassis lubricant per minute at 70 F with 150 psi air pressure. *Alemite Div., Stewart-Warner Corp., Chicago, Ill.*

Testing and Inspection

BINOCULAR MISCROSCOPE: Wide-field miscroscope with attachment for counting threads in fabrics. Model A low-power furnished with two pairs of eyepieces giving total magnifications of 4¼X and 6½X with fields of 1.7 and 1.3 in. Model B high-power instrument has three eyepieces giving 10X, 20X and 30X magnifications with fields of 0.63, 0.43 and 0.32-in. Focal distances for low and high power models, 8⅜ and 3⅛ in., respectively. *George Scherr Co. Inc., New York, N. Y.*

GEAR TESTER: For testing automatic transmission low planet pinions for nicks. Power spindle carries master gear, drives work pinion slipped onto second spindle. Workhead locks to engage two gears. Returning rocking handle cuts off power, brakes both spindles. *National Broach & Machine Co., Detroit, Mich.*

Woodworking Equipment

PORTABLE SAW: New lightweight 6-in. saw with universal, 60-cycle or less, 5600-rpm motor. Bevels at any angle to 45 degrees to 1½-in. depth. Cuts to two in. at 90 degrees. Housing of diecast aluminum with steel base, helical gears. Net weight, 10 lb. *Stanley Electric Tools, Div. of The Stanley Works, New Britain, Conn.*

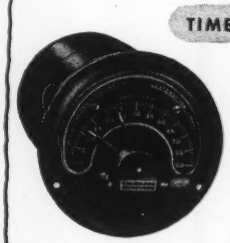
RADIAL ARM SAW: Model GR power saw features low-dead rise, direct-drive, totally-enclosed motor. Reduced distance from bottom of motor casing to saw arbor permits feeding of thicker stock. Saw cuts to 4½ in. deep with 14-in. blade. Available with motors from 2-hp ac-dc to 3-hp single phase and from 3 to 5-hp polyphase. *DeWalt Inc., Lancaster, Pa.*

PRECISION TIME CONTROL by Cramer

PERCENTAGE TIMERS

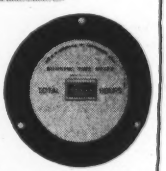
Automatically control the percentage of time at which circuit can be closed or opened out of a definite length of time. Adjusted from the front, can be set from 5% to 197% of total cycle. Write for Bulletin 2500G.

TIME DELAY RELAYS



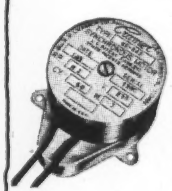
Provides adjustable or fixed time delay between closing and opening of a load circuit. Has automatic re-set feature which restores timer to its normal starting position when control circuit fails or is de-energized. Also available with reverse clutch which prevents re-set in case of power failure. Write for Bulletin 800H.

RUNNING TIME METERS



Synchronous motor driven, automatically and cumulatively register the total operating time or idle time on any circuit, machine or system. Also available with re-set feature. Write for Bulletin 3500E.

SYNCHRONOUS MOTORS



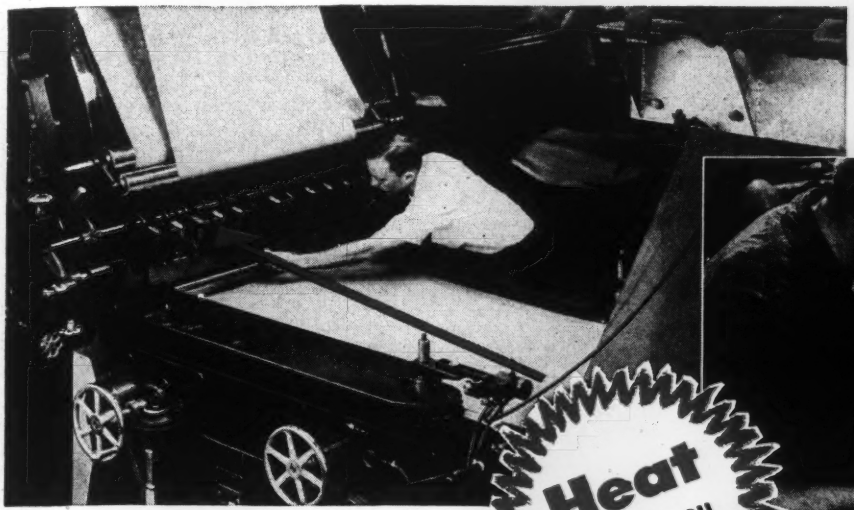
Efficient, powerful, self-starting synchronous motors for applications requiring constant speed at given frequency. Compact...precision-built... available with output speeds from 60 RPM to 1/24 RPH. Write for Bulletin 10D.

If the performance of your product depends on precision timing, send us full particulars about your application. In developing a range of devices for a great variety of commercial and industrial timing duties, we have had wide experience in the design of equipment to meet many specific needs... and will welcome the opportunity to assist in solving your problem.

THE R. W. CRAMER COMPANY, INC.
Box 6, Centerbrook, Connecticut
8CR50

CALROD* HEATERS

"Simplest, easiest, and most reliable way to build heat into your product," says Morrison Machine Co.



This Morrison machine, built with G-E Calrod cartridge heaters, accurately shrinks the fabric in warp and weft. Temperatures, controlled by thermostats, are varied according to the fabric being shrunk.

Only a few minutes are required to insert the cartridge heaters into the heating shoes, connect the leads, and fit the shoes over the blanketed cylinders of the shrinking machine.

LIKE THE MORRISON MACHINE CO., designers and builders of textile machinery, you may find that the simplest, easiest, and most reliable way to build heat into your product is with G-E Calrod heaters—tubular, cartridge, strip or fin.

The Morrison Co., faced with the problem of building intense, controllable heat into machines for shrinking textiles as they roll at high speed off the looms, picked G-E Calrod heaters. Here's why—

1. Use of G-E Calrod heaters cut machine manufacturing costs—workmen need only insert the heaters in the heating shoes and connect the leads.

2. Use of G-E Calrod heaters increases customer acceptance and satisfaction because the heaters are reliable and easy to operate.

The trademark, "Calrod," famous for 24 years, is a guarantee to customers that these heaters are designed to stand up under 'round-the-clock schedules. Customers can get maximum use of machinery and maximum output.

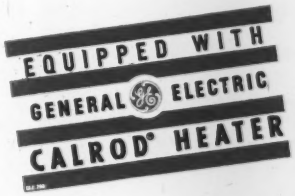
The heaters are easily controlled by thermostats, which can be set for the desired temperature up to 750 F.

** Registered Trademark of General Electric Co.*

Before You Design your equipment for repetitive manufacture, get together with the G-E heating specialist in your nearest G-E office. He'll be glad to help solve your heating problems by selecting from our stock of heaters available in a wide range of standard sizes, ratings, and sheath materials.

NEW, FREE CATALOG

Write us on your letterhead for Bulletin GEC-1005A. And, if you'll also tell us about your heating problems, we'll send you application bulletins to help you select and correctly apply the right heaters to give you heat *where* you want it . . . *when* you want it . . . and in the *amount* you want it. Section 720-29, Apparatus Dept., General Electric Co., Schenectady 5, N. Y.



NEW SELLING AID

These labels, with a gummed back to enable you to place them on your machinery, are now available.

GENERAL ELECTRIC

720-29

1950 ANNUAL INDEX

Volume 22

January to December

Author Index

Allison, George E. and Alfred Salem Niles—"Designing Tubes for Bending Loads," (Data Sheet), Nov., 163
Archibald, Frank R.—"Stepped Film Bearings," Dec., 171
Argentieri, Michael A.—"Flight Control Unit," Nov., 143

Baninger, John H.—"Selecting Antifriction Bearings," Mar., 134
Beckwith, Walter and John R. Weske—"Accurate Hydraulic Pressure Control," Mar., 121
Bent, Arthur J.—"Automatic Brake Control," Feb., 140
Bergstrom, A. G. and R. Q. Sharpe—"Give Life to Hydraulic Systems," Jan., 80
Bidigare, G. S. and R. E. VanDeventer—"Induction Brazing Reduces Cost," Sept., 140
Blasutta, V.—"Modified Geneva Drive Speeds Indexing," Jan., 106
Blood, H. L.—"Designing Housings and Spindles for Antifriction Bearings," Mar., 138
Bolz, Roger W.
"Production Processes. . .Their Influence on Design:
Investment Casting," Jan., 93
Plastics Molding," May, 111
Rubber Molding," June, 139
Molded Ceramics," Aug., 145
"High-Pressure Hydraulics," Sept., 156
"Rotary Pistons," Feb., 116
Bolz, Roger W., John W. Greve, Robert R. Harnar, and Robert E. Denega—"High Speed Drives and Controls in Design," Apr., 147
Brown, Norman N.
"Steel Heat Treatments. . .Their Selection and Specification:
Toughness," Oct., 88
Hardness," Nov., 115
Combination Hardness and Toughness," Dec., 138
Brunner, Alex—"Determining Permissible External Axial Loads on Steel Bolts," June, 124
Bush, R. R.—"Bearings for Intermittent Oscillatory Motion," Jan., 117

Carey, Norman W.—"Maximum Energy in a Minimum Length for Given Coil Diameter of Spring," Mar., 129
Carrier, G. F.—"Skewed Rolls," Nov., 136
Carter, William J. and V. L. Doughtie—"Bolted Assemblies," Feb., 127
Chaffee, Randolph W.
"Engineering Management—Its Job:
Responsibilities of Engineering," June, 102
Organization of Engineering," July, 115
Planning of Engineering," Aug., 117
Direction of Engineering," Sept., 111
Chase, Herbert—"High-Temperature Fans," Feb., 119
Ching-U Ip—"Transverse Vibration of Loaded Shafts," June, 137
Conway, H. G.
"Highlights in the History of Machine Hydraulics:
Rotary Pumps," Jan., 104
Automatic Circuits," Feb., 114
Impulse Pumps and a Pump Mechanism," Mar., 114
Pumps, Motors and Valves," May, 124
Servomechanisms and Hydraulic Motors," June, 148
"Straight-Line Linkages," Jan., 90
Cooper, Herbert—"Centrifugal Casting for Critical Components," Nov., 131
Corteggiano, W. L.—"Production Case Hardener," July, 125
Crede, Charles E. and Miguel C. Junger—"Designing for Shock Resistance," Dec., 161
Creech, Merl D. and George W. Randle—"Planetary Gear Train Analysis," May, 101
Critchlow, John P.—"Oil Lubrication of Antifriction Bearings," Mar., 135

Cunningham, Frederick W.
"Employing Computer Components in Machine Control:
Adding and Subtracting," May, 131
Complex Operations," June, 133
Applications," July, 153

Denega, Robert E., Roger W. Bolz, John W. Greve, and Robert R. Harnar—"High-Speed Drives and Controls in Design," Apr., 147
Denny, K. R. and J. J. Sloan
"Designing Low-Cost Forgings," Aug., 154
"Determining Practical Forging Cost," Sept., 151
Dorfman, H. D.—"Overcenter Toggle Improves Design," Jan., 100
Doughtie, V. L. and William J. Carter—"Bolted Assemblies," Feb., 127
Durelli, A. J. and R. L. Lake—"Three-Dimensional Photoelasticity," Dec., 122

Frangos, T. F.—"Tolerances for Investment Castings," Oct., 107
Frey, George J.—"Simplifying Offset Crank Analysis," July, 156

Gagne, A. F., Jr.
"One-Way Clutches," Apr., 120
"Design of High-Speed Cams," July, 108
Gagnebin, Albert P., Keith D. Millis and Norman B. Pilling—"Engineering Applications of Ductile Cast Iron," Jan., 108
Goldhammer, J. S.—"Memory Control Speeds Processing of Aerial Photographs," Feb., 107
Greene, Jerome—"Calculating Fillet Radius of Gear Teeth," Mar., 126
Greve, John W., Roger W. Bolz, Robert R. Harnar, and Robert E. Denega—"High-Speed Drives and Controls in Design," Apr., 147
Grodzinski, Paul—"Bevel Gear Trains," Mar., 108
Gutman, Alfred S.—"Designing an Eddy Current Clutch Servo," Oct., 109

Harnar, Robert R.—"Automatic Automotive Drives," Apr., 136
Harnar, Robert R., Roger W. Bolz, John W. Greve, and Robert E. Denega—"High-Speed Drives and Controls," Apr., 147
Hauser, L. G.—"Designing a Large Weldment," Dec., 168
Hicks, Tyler G.
"Graphical Solution of Press Fit Calculations," (Data Sheet), Jan., 125
"Charts Simplify Calculations of Bending Forces," Mar., 127
"Punching Power and Drawing Forces Charts," May, 129
"Turning and Boring Charts Simplify Calculations," June, 150
"Milling Feed and Time Calculation Charts," July, 151
Hilficker, Edward G.—"How To Layout Centrifugal Pump Impellers," Nov., 137
Hochman, Aaron—"Design of Ball and Roller Bearings," Mar., 132
Hunt, John T.—"Determining Radius of Gyration," (Data Sheet), Aug., 161

Jaeschke, R. L.—"Novel Transmission Improves Truck Performance," Apr., 133
Johnson, Walter G.—"The Target is Cost," Feb., 100
Junger, Miguel C. and Charles E. Crede—"Designing for Shock Resistance," Dec., 161

Kantor, J.—"Friction Drive," Apr., 116
Kaufman, Alvin B.—"Shaft Speeds and Vibrations," Jan., 87
Keyes, John H.—"Nomographic Design of Helical Springs," (Data Sheet), Dec., 173

Koons, H. O.—"Isolating Generator Bearings from Stray Magnetic Flux," Mar., 98
Kremer, John
"Milestones in Design:
The Dictating Machine," Aug., 140
The Typewriter," Nov., 154

Lake, R. L., and A. J. Durelli—"Three-Dimensional Photoelasticity," Dec., 122
Lemmon, D. C., J. A. Sauer and E. K. Lynn—"How To Prevent Bolt Loosening," Aug., 133
Leopold, W. R.
"Torque Capacity of Bolted Couplings," (Data Sheet), Feb., 151
"Torque Capacity of Splined Connections," (Data Sheet), Mar., 143
"Gear Wear Load," (Data Sheet), July, 159
Lindemuth, F. L.—"Gear Beam Strength," (Data Sheet), July, 157
Lipson, Charles
"Why Machine Parts Fail:
Fracture and Inherent Strength," May, 95
Origin and Growth of Cracks," June, 111
Modes of Failure," July, 141
Fatigue Fractures," Aug., 157
Bending and Tensile Fractures," Sept., 147
Torsional Fractures," Oct., 97
Failures on the Drawing Board," Nov., 158
When Not To Blame the Designer," Dec., 151
Lupton, Clark R. and W. R. Rodger—"Drum and Disk Brake Design," July, 146
Lynn, E. K., J. A. Sauer, and D. C. Lemmon—"How To Prevent Bolt Loosening," Aug., 133

Mackas, George—"Sealing a 39-Ton Door," Jan., 101
Marker, Roy C.—"Determining Toggle Jaw Force," Mar., 104
Mathi, W. E. and C. K. Studley Jr.—"Developing a Counting Mechanism for High-Speed Calculating Machine," June, 117
Maxwell, Alexander—"Electronic Inspection Machines," Mar., 140
McAninch, H. A.—"Designing a Power Take-Off for Production," Mar., 101
McKee, S. A. and H. S. White—"Effects of Oil Holes and Grooves on Bearing Performance," Aug., 143
Millis, Keith D., Albert P. Gagnebin and Norman B. Pilling—"Engineering Applications of Ductile Cast Iron," Jan., 108
Mitchell, D. B.—"Cam Follower Dynamics," June, 151
Moody, John L.—"Designing for High Production," May, 103
Mosher, Fred D.—"Helical Gated Rotors in Axial-Flow Blower," Feb., 137
Mundel, M. E.—"Improving Machine Design Through Motion Study," Mar., 90

Nachod, Carl P.—"Graphical Solution of Quadratic Equations," (Data Sheet), June, 155
Newton, George C., Jr.—"What Size Motor for Servo Applications?" Nov., 125
Niles, Alfred Salem and George E. Allison—"Designing Tubes for Bending Loads," (Data Sheet), Nov., 163

Painter, David—"Styling Trends," Nov., 146
Pickels, E. G.—"Precision Speed Control," Sept., 102
Pilling, Norman B., Albert P. Gagnebin and Keith D. Millis—"Engineering Applications of Ductile Cast Iron," Jan., 108
Posser, Fred H.—"Locating Axis of Rotation of a Moving Link," July, 129
Procopi, John—"Control Valves. . .Their Design and Selection," Sept., 153

Randle, George W. and Merl D. Creech—"Planetary Gear Train Analysis," May, 101
Rappaport, Sigmund—"Weighing Speed of Hydraulic Scales Predicted by Simple Analysis," Jan., 115
Rodger, W. R. and Clark R. Lupton—"Drum and Disk Brake Design," July, 146
Rogers, Dayton A.—"Design Details for Stamped Parts," Dec., 157
Rudorf, Sigurd K.—"Design for Safety," Dec., 113

Sauer, J. A., D. C. Lemmon and E. K. Lynn—"How To Prevent Bolt Loosening," Aug., 133
Schmidbauer, Hans—"Sheet-Metal Shapes," Feb., 122
Schwartz, F. L.—"Chart Aids Design of Axial-Flow Turbines," (Data Sheet), Apr., 195
Schwarz-Kast ,E. L.—"Synchronized Drives with Standard Electric Motors," Apr., 142
Shainin, Dorian—"Predicting Machine Capability," Jan., 72
Sharpe, R. Q. and A. G. Bergstrom—"Give Life to Hydraulic Systems," Jan., 80
Sloan, J. J. and K. R. Denny
"Designing Low-Cost Forgings," Aug., 154
"Determining Practical Forging Cost," Sept., 151
Soroka, Walter W.—"Bars in Torsion," July, 120
Studley, C. K., Jr. and W. E. Mathi—"Developing a Counting Mechanism for High-Speed Calculating Machine," June, 117
Sutton, George P.—"Rocket Motor Hydraulics," May, 86

Talbourdet, Guy J.
"Intermittent Mechanisms:
Planetary System," Sept., 141
Screw and Gear," Oct., 121
Thearle, Ernest L.
"Automatic Dynamic Balancers:
The Leblanc Balancer," Sept., 119
Ring, Pendulum and Ball Balancers," Oct., 103
Designing for Effectiveness," Nov., 149
Tuplin, W. A.—"Designing Crossed Helical Gears," Aug., 125

VanDeventer, R. E. and G. S. Bidigare—"Induction Brazing Reduces Cost," Sept., 140
Van Hamersveld, John—"Design Economics. . .Quantity Production," July, 128

Waller, L. G.—"High-Speed Motion Pictures Aid Design," Dec., 143
Warren, P. H., Jr.—"Transfer Plates Simplify Complex Hydraulic Installations," Mar., 111
Weigel, F. W.—"Hardfacing," May, 126
Weske, John R. and Walter Beckwith—"Accurate Hydraulic Pressure Control," Mar., 121
White, H. S. and S. A. McKee—"Effect of Oil Holes and Grooves on Bearing Performance," Aug., 143
Williams, James—"Redesign for More Economical Manufacture," Nov., 133
Wilson, Warren E.—"Hydraulic Pumps and Motors," Aug., 108
Wood, Homer J.—"Hydraulic Differential Drive," Apr., 129
Woodhouse, Harold—"Impeller Blade Design," Feb., 111
Woodson, Thomas T.—"Built-In Motors," Sept., 125

Ziebolz, H.—"Systematic Design of Mechanisms," Dec., 126

Subject Index

A

Actuators
ac-dc rotary (Airborne Accessories Corp.)*, July, 169
ac-dc rotary and linear (Airborne Accessories Corp.)*, May, 152
d-c, rotary (Lear Inc.)*, Sept., 172
electromagnetic, rotary (Lear Inc.)*, Feb., 158
electromechanical (Hydro-Aire Inc.)*, Dec., 180
hydraulic (Benjamin Lassman & Son)*, Aug., 174
linear, synchronized (Airborne Accessories Corp.)*, Jan., 136
Accumulators
air-operated (Miller Motor Co.)*, July, 166
hydraulic (Vickers Inc.)*, Oct., 138
Adapters, packing (Gilson Co.)*, Oct., 136
Aircraft
design improvements, Jan., 162
engine design, July, 220
flight control, Nov., 143
generation of fuselage and windshield shapes, Feb., 122
Alternators, high-frequency (American Electric Motors Inc.)*, May, 143
Amplifiers, magnetic (Vickers Inc.)*, Sept., 164
Axis of rotation, determination, July, 139

B

Backstop, ratchet type (American Pulley Co.)*, May, 142
Balancers, automatic dynamic
Leblanc, Sept., 119
liquid, Nov., 149
ring, pendulum and ball, Oct., 103
Bars, torsional shear stress, July, 120
Beading, snap-on (Spotrim Corp.)*, Sept., 176
Bearings, ball
annular and radial (Nice Ball Bearing Co.)*, Jan., 136
design and selection, Mar., 132
flanged (New Hampshire Ball Bearings Inc.)*, Sept., 164
flanged, lightweight (Fafnir Bearing Co.)*, Mar., 148
flange unit (Ahlberg Bearing Co.)*, Aug. 168
miniature (New Hampshire Ball Bearings Inc.)*, Feb., 158
matching inner and outer races*, May, 94
miniature, radial (Landis & Gyr Inc.)*, Apr., 198
pillow blocks (Congress Drives Div., Tann Corp.)*, May, 144
Bearings, roller
cageless (McGill Mfg. Co.)*, Sept., 176
design and selection, Mar., 132
isolating from stray magnetic flux in generator, Mar., 98
oil pressure method for mounting or dismounting*, Jan., 78
Bearings, sleeve
effects of oil holes and grooves on performance, Aug., 143
glass (Farley M. Caldwell)*, June, 157
oil-impregnated (Boston Gear Works)*, Oct., 136
oil leakage elimination*, June, 196
stepped film, Dec., 171
sintered metal (Michigan Powdered Metal Products Co.)*, Mar., 152
Bearings, intermittent, oscillatory motion, Jan., 117
Bellows, stainless steel (Chicago Metal Hose Corp.)*, Aug., 170
Belts
conveyer (May-Fran Engineering Inc.)*, Sept., 166
lightweight (Baldwin Belting Inc.)*, Dec., 186
nonstretching leather (S. R. Sikes Co.)*, Sept., 174
tension adjusted by compression spring, May, 106
transmission, high-speed characteristic, Apr., 157
V, high-strength (Goodyear Tire & Rubber C.)*, June, 166
V, leather-rayon bonded (Charles A. Schieren Co.)*, May, 152

*Denotes short articles of less than one page.

Bending forces, U and V dies, Mar., 127
Blades, turbine, design charts, (Data Sheet), Apr., 195
Blowers, axial-flow helical-gated rotor, Feb., 137
Bolts
  assemblies, size and tightening stress, Feb., 127
  loosening, Aug., 133
  permissible external axial loads, steel, June, 124
Boosters, hydraulic, fluid pressure (Miller Motor Co.)*, June, 160
Boring and turning cutting time charts, June, 150
Brakes
  automatic control, Feb., 140
  disk, July, 148
  disk, C-shape*, June, 196
  drum, July, 146
  hydraulic, controlled drum and friction clearance,* Aug., 194
Brazing, induction, reduces cost, Sept., 140
Brazing and soldering gun (Metallizing Co. of America)*, Oct., 84

C

Cable, shielded coaxial (Precision Tube Co.)*, July, 166
Calculating machine, high-speed counter, June, 117
Calender, textile (Van Valaanderen Machine Co.)*, Sept., 133
Camera, high-speed slit type,* Nov., 120
Camera, synchronous (Flight Research Engineering Corp.)*, Feb., 170
Cams
  adjustable*, July, 114
  follower dynamics, June, 151
  high-speed, July, 108
  intermittent claw film drive*, June, 198
Capacitors
  electrolytic (General Electric Co.)*, June, 166
  small tubular (Aerovox Corp.)*, Mar., 146
  tantalum*, Sept., 96
Casters
  cold-forged (Rapids-Standard Co.)*, Jan., 138
  forged-steel (Rapids-Standard Co.)*, Aug., 168
  heavy-duty (Aerol Co.)*, Apr., 199
Casting
  centrifugal, Nov., 131
  centrifugal (American Non-Gran Bronze Co.)*, Mar., 156
  investment, Jan., 93
  investment, tolerances, Oct., 107
  permanent mold, brass slabs for cold rolling, continuous, Feb., 143
Case hardener, July, 125
Chains
  roller (Diamond Chain Co.)*, Sept., 164
  roller (Chain Belt Co.)*, Feb., 158
  roller (Chain Belt Co.)*, Feb., 168
  mechanical, miniature (Sierra Engineering Co.)*, Jan., 135
  transmission, high-speed characteristics, Apr., 150
Chopper, ac-dc (Stevens-Arnold Inc.)*, Nov., 176
Circuit breaker, air (Federal Electric Products Co.)*, Aug., 167
Circulator, air, miniature*, Dec., 148
Clamp, pneumatic (Lapeer Mfg. Co.)*, Nov., 176
Clamp, self-bonding cushion (Thomas Associates)*, Feb., 155
Cleaner-regulator, air (Logansport Machine Co.)*, July, 171
Clutches
  centrifugal, controlled by tension spring*, Sept., 129
  disk, lubrication*, Nov., 200
  disk (Edgemount Machine Co.)*, Jan., 136
  eddy-current, Apr., 133
  eddy-current*, July, 184
  electromagnetic*, Jan., 132
  friction, adjustable*, Feb., 194
  load limiting, adjustable spring release, Apr., 230
  magnetic (Barber-Colman Co.)*, June, 166
  magnetic particle (Vickers Inc.)*, Aug., 165
  mechanism, magnetic, computing devices (Sperry Corp.)*, Sept., 188
  motor reversing, Aug., 114
  one-way, Apr., 120
  pulley, variable pitch (Light Inspection Car Works)*, Apr., 198
  reversible overrunning*, Feb., 196
  servo, eddy-current, Oct., 109
  slip (Hilliard Corp.)*, Nov., 178
  stationary magnetic coil, Apr., 232
  synchronized (Western Electric Co.)*, Sept., 190
Coil winder, high-speed*, Oct., 118
Collector heads, current (Sciaky Bros. Inc.)*, Apr., 198
Collector rings, slow-speed (Industrial Electric Works)*, July, 166
Computer components in machine control, adding and subtracting, May, 131
Computer components in machine control, applications, July, 153
Computer components in machine control, complex operations, June, 133
Computing machine*, Feb., 142
Conductor, electrical, low-tension (General Motors Corp.)*, June, 168
Conductor, electrical, nickel-clad copper (Sylvania Electric Products)*, May, 142
Conduit, flexible metallic (Chicago Metal Hose Corp.)*, Mar., 152
Connections, splined, torque capacity, (Data Sheet), Mar., 143
Connector, armored cable (Unimatic Corp.)*, July, 167
Connector, electrical, (Thomas & Betts Co.)*, Sept., 174
Contactor, a-c magnetic (Euclid Electric & Mfg. Co.)*, Feb., 154
Contactor, magnetic (Sigma Instruments Inc.)*, Oct., 131
Container cleaning and filling machine, Aug., 130
Contour boring or turning accomplished by compound motion of two slides*, Jan., 123
Contour projector, six lens, Aug., 128
Controls
  bearing temperature (Assembly Products Inc.)*, Sept., 170
  centrifuge speed, Sept., 102
  complex machine operations, computer components, June, 133
  current, pneumatic (Conoflow Corp.)*, June, 159
  drive, air-operated (Bailey Meter Co.)*, Aug., 165
  electric (Hart Mfg. Co.)*, Sept., 168
  electric, lathe cross slide for constant speed*, June, 108
  hydraulic, adjustable speed indexing, Jan., 106
  mechanical, ink flow, June, 129
  machine adding and subtracting operations, computer components, May, 131
  machine, computer components, applications, July, 153
  photoelectric (Photoswitch Inc.)*, Apr., 204
  push-pull (Simmonds Aerocessories Inc.)*, Oct., 131
  push-pull casings (Kupfrian Mfg. Co.)*, Apr., 202
  safe operation, design for, Dec., 113
  stations (Westinghouse Electric Corp.)*, Oct., 132
  stations, oiltight (Westinghouse Electric Corp.)*, Mar., 152
Converter, 60-cycle to three phase 400-cycle*, Feb., 104
Conveyer, pressurized, for bulk material*, Mar., 96
Conveyer, transfer*, July 112
Counters
  electric, small (Production Instrument Co.)*, May, 145
  electronic (Potter Instrument Co. Inc.)*, Feb., 170
  four-digit, electromagnetic (Abrams Instrument Corp.)*, Mar., 148
  index cards, automatic*, Jan., 122
  photoelectric (Photoswitch Inc.)*, Sept., 170
Counterbalancing, spring, Nov., 166
Couplings
  bolted, torque capacity, (Data Sheet), Feb., 151
  channel band (Marman Products Co.)*, May, 146
  flexible*, Dec., 200
  flexible (Gerbing Mfg. Co.)*, Aug., 166
  flexible (Falk Corp.)*, May, 143
  flexible (Lovejoy Flexible Coupling Co.)*, Apr., 200
  flexible (Ajax Flexible Coupling Co. Inc.)*, Nov., 176
  high-speed shaft (Allis Chalmers Mfg. Co.)*, Mar., 147
  hydraulic (Twin Disc Clutch Co.)*, July, 165
  quick-release*, Nov., 112
  self-locking one-way drive (Aero Supply Mfg. Inc.)*, Sept., 194
  swivel pipe (Gil-Lair Products Inc.)*, Feb., 162
  v-band (Marman Products)*, Mar., 154
Crank, offset, analysis of, July, 156
Cylinders
  hydraulic (Hanna Engineering Works)*, Oct., 136
  hydraulic and pneumatic (Ledeen Mfg. Co.)*, Apr., 204
  hydraulic, high-pressure (Hannifin Corp.)*, June, 157
  fluid, low-pressure (Hannifin Corp.)*, Nov., 179
  oil hydraulic (Vickers Inc.)*, May, 148
  pneumatic (Ledeen Mfg. Co.)*, Apr., 204
  pneumatic, double-acting (Modernair Corp.)*, June, 162
  pneumatic, small (Air-Mite)*, Sept., 168

D

Deep drawing*, May, 92
Design for production, low-cost, Feb., 100; Feb., 153; Mar., 101; May, 103; July, 128; Nov., 133
Dial, counting, ten-turn (George W. Borg Corp.)*, June, 158
Dial, time delay relay (A. W. Haydon Co.)*, Aug., 170
Dictating machine, Aug., 140
Drafting
  compass, beam (V & E Mfg. Co.)*, Dec., 188
  drawing board, collapsible (Frank E. deBeu & Co.)*, Apr., 208
  drawing board, lightweight (Cal-Pan Corp.)*, Jan., 140
  erasing tool, electric (Dremel Mfg. Co.)*, Mar., 158
  paper and cloth, diazotype (Technifax Corp.)*, Jan., 142
  paper, diazo-sensitized (Technifax Corp.)*, June, 170
  paper, electrosensitive (Alfax Paper & Engineering Co.)*, Feb., 170
  paper, transparent negative (Haloid Co.)*, Oct., 140
  pen, felt-pointed indelible (Marsh Stencil Machine Co.)*, Mar., 158
  scale, all-metal (Cal-Pan Corp.)*, May 154
  sharpener, lead (Rajean Mfg. Co.)*, Aug., 176
  slide-rule-gage-protractor unit (Dall Inc.)*, Jan., 140
  template, bolt and nut (Rapidesign Inc.)*, Aug., 176
  template, sketch scale (Rapidesign Inc.)*, Mar., 158
  template, squares (Rapidesign Inc.)*, Apr., 208
  tracing board, portable (Stacor Equipment Corp.)*, May, 154
  transfer form, title block and standard notes (Stanpat)*, Mar., 158
  whiteprinter (Charles Bruning Co.)*, Jan., 142
  whiteprinter (Peck & Harvey)*, Oct., 140
Drafting room lighting methods, Sept., 234
Drawing force and punching power charts, May, 129
Drives
  adjustable-speed (Sterling Electric Motors Inc.)*, Dec., 186
  adjustable-speed (Airborne Accessories Corp.)*, Nov., 179
  adjustable-speed, heavy-duty (Lima Electric Motor Co.)*, May, 150
  adjustable-speed, reversible (Revco Inc.)*, May 144
  automatic, automotive, Apr., 136
  belt, high-speed, Apr., 157
  chain, high-speed, Apr., 150
  friction, beverage mixer, Apr., 116
  gear, high-speed, Apr., 168
  geneva, variable speed indexing, Jan., 106
  hydraulic differential, Apr., 129
  motor, high-speed, high-cycle, Apr., 185
  motor, high-speed pneumatic, Apr., 177
  synchronized with standard electric motors, Apr., 142
  variable-speed (Speed Control Corp.)*, Dec., 184
  variable-speed (Allis-Chalmers Mfg. Co.)*, Feb., 156
  variable-speed (U. S. Electrical Motors Inc.)*, Aug., 165
Drum winder, coning yarn, Sept., 131

E

Elbow, corner, pull-in (Gedney Electric Co.)*, July, 166
Electrode, aluminum welding (Eutectic Welding Alloys Corp.)*, Apr., 202
Electrode, mild steel (Lincoln Electric Co.)*, July, 167
Engineering department (see Management)
Engines
  aircraft, July, 220
  gasoline, lightweight (Power Products Corp.)*, Feb., 156
  portable saw, Mar., 118

*Denotes short articles of less than one page.

F

Fabric printer (Rice Barton Corp.)*, Sept., 137
Fabric weaver (Crompton & Knowles Loom Works)*, Sept., 135
Fans, high-temperature, Feb., 119
Fasteners
  bearing, locking (Link-Belt Co.)*, Apr., 198
  bolted assemblies, Feb., 127
  cage nut (Prestole Corp.)*, Oct., 134
  capscrew, button head sockets (Holo-Krome Screw Corp.)*, July, 170
  locking, vibrationproof (South Chester Corp.)*, June, 162
  locking, nut (Boots Aircraft Inc.)*, Dec., 180
  pin, slotted (Elastic Stop Nut Corp. of America)*, Nov., 178
  rivet, pull-through, self-plugging (Huck Mfg. Co.)*, Jan., 135
  self-locking (Grip-Nut Co.)*, Sept., 176
  self-locking nut (Boots Aircraft Nut Corp.)*, July, 172
  self-locking, setscrew (Set Screw & Mfg. Co.)*, Jan., 133
  spin-lock screw (Russell, Burdsall & Ward Bolt & Nut Co.)*, Sept., 177
  spring-steel stud retainer (Security Locknut Corp.)*, June, 159
Feeders
  hopper*, Feb., 105
  hopper (Feedall Machine & Engineering Co.)*, Mar., 145
  mechanism controlled by paper stock supplies*, Feb., 146
  press stock, hydraulic, ram actuated, Feb., 135
  thread miller, May, 109
Fiber blender (Proctor & Schwartz Inc.)*, Sept., 134
Filters
  air (Donaldson Co.)*, May, 143
  air (Scovill Mfg. Co. Inc.)*, Nov., 178
  air-fluid (Sparkler Mfg. Co.)*, Mar., 156
  disposable, vacuum cleaner, Jan., 120
  in-line (Waterman Engineering Co.)*, Feb., 156
  liquid line (Marvel Engineering Co.)*, Mar., 146
  pneumatic, (Airlube Inc.)*, June, 168
  regulator unit, air (C. A. Norgren Co.)*, Jan., 138
  system, self-cleaning*, Jan., 79
Finishes
  chromium plating, fatigue effects on parts, Aug., 124
  enamel, fast-drying synthetic (United Lacquer Mfg. Corp.)*, May, 152
  latex, protective coating*, Oct., 84
  protective (End-O-Rust Inc.)*, June, 157
  protective, plastic (Dampney Company of America)*, Mar., 148
Fittings
  aluminum tube (Scovill Mfg. Co.)*, Feb., 158
  cap, plastic (S. S. White Dental Mfg. Co.)*, Feb., 156
  compression (Dresser Mfg. Div. Dresser Industries Inc.)*, Oct., 125
  tube (Aircraft Fitting Co.)*, Apr., 202
  tube (Crawford Fitting Co.)*, Oct., 138
  tube (Flodar Corp.)*, Oct., 134
  tube (Lenz Co.)*, Nov., 172
  swivel (Rasmussen Mfg. Co.)*, Sept., 166
Flowmeter, electronic*, Dec., 120
Forgings, low cost, Aug., 154
Forgings, cost determination, Sept., 151
Fracture analysis, machine parts
  fracture and inherent strength, May, 95
  origin and growth of cracks, June, 111
  modes of failure, July, 141
  fatigue fractures, Aug., 157
  bending and tensile fractures, Sept., 147
  torsional fractures, Oct., 97
  drawing board failures, Nov., 158
  when not to blame the designer, Dec., 151

G

Gages
  coating thickness (Krouse Testing Machine Co.)*, Feb., 170
  diameter change in tensile test specimen*, Mar., 96
  pressure (Clapp Instrument Co.)*, Nov., 176
  pressure, magnetic linkage*, Jan., 77
  self index, test brakes bends, Mar. 96
  strain*, Jan., 79
  vacuum*, Sept., 109
  vacuum (F. J. Stokes Machine Co.)*, Jan., 142
Gaskets
  flange, Teflon (Chicago Gasket Co.)*, Nov., 176
  flexible bonded silicone rubber and Fiberglas (Stalwart Rubber Co.)*, Jan., 136
  high-pressure (Flexitallic Gasket Co.)*, Dec., 178
  snap-on, self-centering (United States Gasket Co.)*, Jan., 137
Galvanometer, spherical, for two-dimensional scanning*, Feb., 106
Gear box, reduction (Link Aviation Inc.)*, Nov., 174
Gears
  bevel, Aug., 182
  bevel, shaft angles of intermediate gears, Mar., 108
  crossed helical, Aug., 125
  fillet radius of full fillet gear teeth, calculations, Mar., 126
  high-speed characteristics, Apr., 168
  induction heat treating, Sept., 226
  internal planetary, intermittent mechanisms, Sept., 141
  nylon, sprinkler drive, Mar., 119
  planetary, train analysis, May, 101
  sets, standardized (Foote Bros. Gear & Machine Co.)*, Aug., 174
  strength calculations, (Data Sheet), July, 157
  wear calculations, (Data Sheet), July, 157
Generator-motor set (Electrical Specialty Co.)*, June, 168
Governor, centrifugal, pneumatic motor*, June, 198
Governor, overspeed (Synchro-start Products Inc.)*, Dec., 186
Grommet, insulated (Automotive Rubber Co.)*, Sept., 174

H

Handles, machine, malleable iron (Reid Tool Supply Co.)*, Apr., 200
Hardfacing*, May, 126
Heaters, finned electric strip (Vulcan Electric Co.)*, July, 172
Heating element rack (Trent Inc.)*, Apr., 206
Heat treating steels
  hardness, Nov., 115
  toughness, Oct., 88
  toughness and hardness, Dec., 138
Hydraulics
  automatic circuits, Feb., 114
  cylinders (Ledeen Mfg. Co.)*, Apr., 204
  differential drive, Apr., 129
  fluid, industrial (Monsanto Chemical Co.)*, Aug., 169
  high-pressure chemical processing machine, Sept., 156
  rocket motor, May, 86
  machine, history, Feb., 114
  manifold, Oct., 94
  motors, history, May, 124
  oil (Gulf Oil Corp.)*, Apr., 204
  piston actuates tapping spindle, June, 130
  piston, rotary, Feb., 116
  power package (Harco Industries Inc.)*, Nov., 172
  pumps, May, 124
  pump-valve unit (Commercial Shearing & Stamping Co.)*, Dec., 184
  servomechanisms and motors, June, 148
  systems, component design and selection of oil, Jan., 80
  transfer plates simplify complex installations, Mar., 111
  valve, history, May, 124
  variable-speed drive control (Reeves Pulley Co.)*, Feb., 168

I

Impeller blade design, Feb., 111
Impellers, centrifugal pump, layout, Nov., 137
Indexing, automatic, geneva drive*, Feb., 104
Indexing, modified geneva drive, Jan., 106
Injection molder, novel heating cylinder, Aug., 131
Inspection machines, electronic, sort products for size, Mar., 140
Instruments
  electrical, portable (Westinghouse Electric Corp.)*, June, 164
  panel (Marion Electrical Instrument Co.)*, Feb., 160
  temperature indicator (General Electric Co.)*, Feb., 156
Interlock, flow control device (General Electric Co.)*, Apr., 206
Interlock, high-voltage safety (W. L. Maxson Corp.)*, May, 144

J

Jig grinder, design features, Nov., 104
Joints
  ball and socket*, July, 186
  ball and socket*, Dec., 204
  expansion, corrugated (Chicago Metal Hose Corp.)*, May, 147
  expansion, pipeline (Chicago Metal Hose Corp.)*, Mar., 147
  revolving, cartridge type (Rotherm Engineering Co.)*, Feb., 168
  rotary swivel pipe (Barco Mfg. Co.)*, Feb., 154
  screw, lightweight (Minit-Joint Co.)*, July, 171
  universal (Universal Products Co. Inc.)*, Oct., 146
  universal (Blood Brothers Machine Co.)*, Feb., 164
  universal (Boston Gear Works)*, Nov., 178
  universal, sliding pistons transmit torque*, Mar., 176

L

Lapping*, May, 93
Latch, cowling (Simmonds Aerocessories Inc.)*, Nov., 174
Letter writer (American Automatic Typewriter Co.)*, Oct., 119
Linkage, constant-force, in washer*, Jan., 122
Lubrication, designing for, July, 216
Lubricators
  centralized (Lincoln Engineering Co.)*, July, 167
  centralized mist (Stewart-Warner Corp.)*, Dec., 178
  centralized, spray (Farval Corp.)*, Nov., 180
  gravity-feed (Trico Fuse Mfg. Co.)*, May, 147
  multiple-feed (Trico Fuse Mfg. Co.)*, Oct., 132
  one-shot, miniature (Bijur Lubricating Corp.)*, Mar., 153
  pneumatic (Airlube Inc.)*, June, 168
  under-feed (Trico Fuse Mfg. Co.)*, Mar., 150

M

Machining accuracy, large parts, Jan., 130
Magnets, nonelectric plate (Eriez Mfg. Co.)*, July, 170
Management
  airline engineering qualification, July, 214
  engineering direction, Sept., 111
  engineering organization, July, 115
  engineering planning, Aug., 117
  engineering, responsibilities, June, 102
  engineers, public relations*, Dec., 176
  engineer's role in community affairs*, Aug., 230
  industrial designers, organization, May, 202
  patent situation,* Nov., 169
  post graduate training for leadership*, June, 226
Manifold, hydraulic, Oct., 94
Materials
  brazing alloy, silver (Eutectic Welding Alloys Corp.)*, July, 170
  bronze alloy, free-machining (Riverside Metal Co.)*, Jan., 134
  cast iron, ductile, engineering application, Jan., 108
  ceramics in gas turbines, May, 198
  ceramics, molded, Aug., 145
  copper brazing paste (Metals Refining Co.)*, Feb., 154
  copper, nickel-clad (Alloy Metal Wire Co.)*, Oct., 136
  directory of, Oct., 203
  expanded, lightweight (Penn Metal Co.)*, Apr., 201
  glass fiber laminates (U. S. Plywood Corp.)*, Oct., 84
  glass fiber preform*, June, 230

*Denotes short articles of less than one page.

Materials (continued)
glass, safety plate*, Sept., 96
hardfacing alloy (Air Reduction Co.)*, July, 171
hardfacing alloy (Eutectic Welding Alloys Corp.)*, Oct., 131
magnesium extrusion alloy (Dow Chemical Co.)*, Jan., 133
magnesium reduces weight of saw, Mar., 118
magnetic transducer material (Westinghouse Electric Corp..)*, Mar., 147
metal ceramic, Oct., 101
mica, synthetic, higher temperatures applications, Mar., 95
molybdenum fabrication, Oct., 176
nickel alloy T-sections (International Nickel Co.)*, Aug., 168
nylon gears, sprinkler drive, Mar., 119
plastic acrylic molding powder (Rohms & Haas Co)*, Jan., 138
plastic insulating compound (B. F. Goodrich Chemical Co.)*, Aug., 166
plastic insulation (E. I. duPont de Nemours)*, Sept., 166
plastic laminate, Oct., 129
plastic, mineral-filled (Durez Plastics and Chemicals Inc.)*, May, 145
plastic, molded, standard tolerances (Data Sheet), May, 135
plastic, molding, May, 111
plastic, phenolic laminate (Richardson Co.)*, Dec., 184
plastic molding compound (Durez Plastics & Chemicals Inc.)*, July, 168
plastic, motor frame and end bells*, Oct., 96
plastic, textile industry, Oct., 182
plastic, thermosetting resin adhesive (Armstrong Products Co.)*, Feb., 155
plastic, uncharging, Apr., 266
powder metal, Oct., 126
powder metal, friction, Sept., 230
rubber-metal bonded parts (Acushnet Process Co.)*, Jan., 133
rubber molding, June, 139
rubber phenolic molding, Oct., 180
selection of as a key to economy, Oct., 126
silicone-coated fabric (Connecticut Hard Rubber Co.)*, Sept., 176
silicone laminate*, Sept., 96
stainless steel (Armco Steel Corp.)*, Mar., 145
stainless steel, cold-working (Carpenter Steel Co.)*, Apr., 198
steel, chromed rods (Kenmore Metals Corp.)*, July, 171
steel, ground tool (Brown & Sharpe Mfg. Co.)*, May, 146
steel heat treatment, toughness, Oct., 88
steel heat treatments, hardness, Nov., 115
steel, heat treatments, hardness and toughness combined, Dec., 138
steel, magnetic alloy*, Sept., 96
titanium and zirconium fabrication, Oct., 172
Mechanisms
alignment, motor crankshaft and piston assembly (General Electric Co.)*, Oct., 146
counting, high-speed calculating machine, June, 117
intermittent, planetary, Sept., 141
intermittent, screw and gear, Oct., 121
systematic design, Dec., 126
Metalograph, adjustable carbon arc, Dec., 148
Milliameter, volt-ohm-capacity (Hickok Electrical Instrument Co.)*, May, 154
Mill, vibratory ball*, Dec., 121
Miller, dual-head, Aug., 129
Milling feed and time charts, July, 151
Microcard reader, Mar., 117
Mirrors, front-surface (Zenith Optical Laboratory)*, Sept., 176
Molding
ceramics, Aug., 145
plastics,
rubber,
Motion pictures, high-speed, aid design, Dec., 143
Motion study improves machine design, Mar., 90
Motors
a-c built-in, Sept., 125
air, high-speed (Bellows Co.)*, Dec., 182
brakemotor, adjustable (Star Electric Motor Co.)*, Feb., 162
brakemotor, totally enclosed (Elliot Co.)*, Feb., 155
capacitor, high-torque (General Electric Co.)*, Jan., 135
chemicalproof (Westinghouse Electric Corp.)*, May, 148
control (Gleason-Avery Inc.)*, Dec., 182
electric, vibration*, Feb., 192
electric in synchronized drives, Apr., 142
fractional-horsepower (Russell Electric Co.)*, May, 150
fractional-horsepower, brush type (Electric Motor Corp.)*, May, 144
fractional-horsepower (Mission Electric Mfg. Co.)*, July, 168
fractional-horsepower (Russell Electric Co.)*, July, 154
fractional-horsepower (Fasco Industries Inc.)*, Sept., 174
gearmotor (Small Motors Inc.)*, May, 142
gearmotor (Lima Electric Co.)*, Oct., 134
gearmotor (Sterling Electric Motors Inc.)*, Oct., 138
gearmotor (Lima Electric Motor Co.)*, May, 150
gearmotor (Electro Engineering Products Co.)*, Jan., 136
gearmotor (Abart Gear & Machine Co.)*, July, 165
gearmotor (Small Motors Inc.)*, May, 142
gearmotor (Louis Allis Co.)*, Feb., 158
gearmotor (Foote Bros. Gear & Machine Corp.)*, Feb., 158
gearmotor (Century Electric Co.)*, Feb., 166
gearmotor, high-speed*, Feb., 150
high-cycle, Apr., 185
high-speed (Lear Inc.)*, Dec., 180
high-speed (Electric Products Co.)*, Dec., 180
high-speed (Lear Inc.)*, Dec., 184
hydraulic, positive displacement, Aug., 108
induction (General Electric Co.,)*, Aug., 169
induction (Wagner Electric Corp.)*, Aug., 167
induction (Allis-Chalmers Mfg. Co.)*, Oct., 134
permanent magnet (Electro Engineering Products Co.)*, June, 168
pneumatic and hydraulic, Jan., 124
pneumatic, high-speed, Apr., 177
pneumatic (Gast Mfg. Corp.)*, Nov., 180
pneumatic (Bellows Co.)*, Apr., 200
quick-stopping (Standard Dayton Corp.)*, Aug., 168
sanitary (U. S. Electrical Motors Inc.)*, Dec., 182
servo motors, size determination, Nov., 125
shaded-pole (Russell Electric Co.)*, Aug., 172
single phase, reversible (Electro-Aire Inc.)*, Jan., 137
splashproof (Sterling Electric Motors Inc.)*, Mar., 154
textile (Century Electric Co.)*, July, 172
timing (International Register Co.)*, Feb., 168
timing (Haydon Mfg. Co.)*, June, 162
variable-speed, governor controlled*, Feb. 147
Motor base, tilting (Gerbing Mfg. Co.)*, May, 150
Motor-generator unit, refrigerator*, Nov., 196
Motor-generator unit (Electrical Specialty Co.)*, June, 168
Motor reversing device, Aug., 114
Mounts
vibration (Finn & Co.)*, Jan., 138
vibration (Connecticut Hard Rubber Co.)*, Feb., 155
vibration*, Mar., 176
vibration (Korfund Co.)*, June, 158
vibration (Finn & Co.)*, July, 168
vibration (Robinson Aviation Inc.)*, Nov., 170
vibration (Finn & Co.)*, Dec., 182

N

Nameplates, die-stamped (Federal Tool & Mfg. Co.)*, Feb., 166

O

Outlet, electric power, miniature (Alden Products Co.)*, Feb., 164

P

Packings
braided (Greene, Tweed & Co.)*, Dec., 182
cartridge (Emsco Derrick & Equipment Co.)*, July, 169
chemically inert (United States Gasket Co.)*, June, 162
nonjacketed plastic (Raybestos Manhattan Inc.)*, June, 158
shaft and pump (United States Gasket Co.)*, Jan., 134
v-ring, Teflon (Crane [illegible]king Co.)*, Nov., 174
Panelboards, lighting (Square D Co.)*, Apr., 201
Photoelasticity, three-dimensional, Dec., 122
Photoelectric cell, selenium (International Rectifier Corp.)*, May, 145
Photoelectric control (Photoswitch Inc.)*, Apr., 204
Photoelectric unit (General Electric Co.)*, May, 147
Photography, aerial, processing machine, Feb., 107
Photography, high-speed,* May, 160
Pickler, automatic washer principle*, Oct., 119
Pin drafter, yarn processing (Warner & Swasey Co.)*, Sept., 131
Pipe, plastic (Carlon Products Corp.)*, Nov., 174
Pipe, plastic, heavy-wall (Carter Products Corp.)*, Aug., 166
Piston, hydraulic, actuates tapping control, June, 130
Plastic cylinder fabricator, Aug., 132
Plates, flat, uniformly loaded, thickness and deflection, (Data Sheet), Sept., 159
Plates, transfer, simplify complex hydraulic installations, Mar., 111
Plugs, pipe, magnetic (U. S. Plug & Fitting Co.)*, Aug., 174
Plugs, pipe, socket (U. S. Plug & Fitting Co.)*, Sept., 168
Plugs, pipe, vent type (U. S. Plug & Fitting Co.)*, Mar., 154
Potentiometer controller (Wheelco Instruments Co.)*, Aug., 167
Potentiometer, two-watt (Ohmite Mfg. Co.)*, Sept., 168
Power supply, d-c (Superior Electric Co.)*, Mar., 154
Press fit calculations, (Data Sheet), Jan., 125
Press, metal forming, overload protection*, May, 160
Press, printing, electronic, May, 206
Pressure snubber, monel (Chemiquip Co.)*, Feb., 155
Print dryer, portable (Lott Mfg. Co.)*, Aug., 176
Printer, hydraulic, May, 112
Projector, optical, measuring (Stocker & Yale)*, Aug., 176
Pulleys
clutch, variable pitch (Light Inspection Car Works)*, Apr., 198
reduction (Hart Reduction Pulley Co.)*, June, 157
reduction (Hart Reduction Pulley Co.)*, Dec., 184
variable pitch (Gerbing Mfg. Co.)*, July, 167
variable speed (American Type Founders Inc.)*, July, 174
Pumps
air, rotary vane (Aro Equipment Corp.)*, Oct., 138
axial plunger*, Dec., 202
centrifugal, self-priming (Goulds Pumps Inc.)*, Oct., 139
coolant (Ruthman Machinery Co.)*, Aug., 174
fuel injection, Diesel*, July, 184
hydraulic, May, 124
hydraulic (Superdraulic Corp.)*, Feb., 160
hydraulic (Denison Engineering Co.)*, Apr., 206
hydraulic (John Dusenberry Co.)*, Aug., 172
hydraulic, antishimmy device (Bell Aircraft Corp.)*, July, 182
hydraulic, bladeless*, Mar., 97
hydraulic, gear type (Adel Precision Products Corp.)*, July, 165
hydraulic, high-speed (De Laval Steam Turbine Co.)*, July, 169
hydraulic, impeller, process (De Laval Steam Turbine Co.)*, May, 144
hydraulic, impulse, Mar., 114
hydraulic, intermittent (Monarch Road Machinery Co.)*, July, 171
hydraulic, motorized (Allis-Chalmers Mfg. Co.)*, Nov., 172
hydraulic, positive displacement, Aug., 108
hydraulic, vane type (Hydropower Inc.)*, Nov., 170
hydraulic, variable capacity*, Nov., 196
hydraulic, radial cylinder*, May, 162
hydraulic, rotary, Jan., 104
hydraulic, rotary (Chicago Laboratory & Engineering Co.)*, Jan., 134
hydraulic, rotary pistons, Feb., 116
hydraulic, self-priming (Ertel Engineering Corp.)*, Mar., 146
hydraulic, swash plate type*, Jan., 132
hydraulic, variable volume (Denison Engineering Co.)*, Oct., 120
hydraulic, vane, positive displacement (Procon Pump & Engineering Co.)*, May, 146
hydraulic, vertical flow*, Feb., 193
metering (Eastern Industries Inc.)*, Mar., 156
metering (Milton Roy Co.)*, Dec., 187
swash plate*, Dec., 202
Pump impellers, centrifugal, layout, Nov., 137
Pump-turbine unit, Aug., 114
Punching power and drawing force charts, May, 129

*Denotes short articles of less than one page.

Q

Quadratic equations, graphical solution (Data Sheet), June, 155
Quiller, yarn (Abbott Machine Co.)*, Sept., 132

R

Radius of gyration, determination, (Data Sheet), Aug., 161
Ratchet mechanism, reversible*, July, 182
Receptacle, locking (Panalarm Products Inc.)*, Nov., 180
Recorder-controller, program (Gotham Instruments Div., American Machine & Metals Inc.)*, July, 165
Recorders
  strip chart (Wheelco Instruments Co.)*, May, 145
  strip chart (Taylor Instrument Co.)*, June, 170
  strip chart (Baldwin Locomotive Works)*, Jan., 140
  temperature-pressure (Gotham Instruments Div., American Machine & Metals Inc.)*, Aug., 169
Rectifiers
  copper oxide (Bradley Laboratories Inc.)*, Jan., 137
  dry disk (Electronic Rectifiers Inc.)*, Aug., 169
  electronic (Westinghouse Electric Corp.)*, Sept., 176
  grid-controlled (Westinghouse Electric Corp.)*, July, 170
  selenium (Syntron Co.)*, June, 164
  selenium (International Rectifier Corp.)*, Jan., 134
Refrigerator, water refrigerant and salt absorbent*, Mar., 107
Regulator-cleaner, air (Logansport Machine Co.)*, July, 171
Regulator-cleaner, air (Conoflow Corp.)*, Oct., 132
Regulator, fluid flow (Waterman Engineering Co.)*, Oct., 136
Relays
  accelerating, voltage type (General Electric Co.)*, Mar., 148
  current and temperature (Westinghouse Electric Corp.)*, Sept., 172
  d-c high-speed (Stevens-Arnold Inc.)*, Feb., 164
  dust-tight (C. P. Clare)*, Mar., 150
  electronic (Servo-Tek Products Co.)*, Apr., 199
  hermetically sealed (Guardian Electric Mfg. Co.)*, Aug., 165
  hermetically sealed (Advance Electric & Relay Co.)*, Oct., 139
  high-power (Ebert Electronics Corp.)*, Dec. 180
  high-speed (Assembly Products Inc.)*, Oct., 136
  latch type (Leach Relay Co.)*, July, 169
  mercury plunger (Ebert Electronics Corp.)*, Aug., 172
  miniature (Sigma Instruments Inc.)*, Dec., 187
  pneumatic (Moore Products Co.)*, Apr., 200
  pneumatic, timing (Allen-Bradley Co.)*, Feb., 162
  pneumatic, time-delay (Westinghouse Electric Corp.)*, June, 158
  time-delay, low-voltage (Square D Co.)*, May, 143
Resistors, vertical, wire-wound (Shallcross Mfg. Co.)*, Sept., 168
Rods, chromed steel (Kenmore Metals Corp.)*, July, 171
Rod wiper (Hydraulic Accessories Co.)*, May, 146
Rolls, skewed, calendering, Nov., 136

S

Safety, suggestions for machine design, Dec., 113
Scales, hydraulic, predicting weighing speed, Jan., 115
Seals
  cylinder-shaft (Auto-Diesel Piston Ring Co.)*, May, 152
  high-pressure (Felt Products Mfg. Co.)*, Feb., 160
  high-pressure, Jan., 101
  hydraulic (C.A.V. Ltd.)*, Sept., 192
  rotary*, Jan., 78
  shaft, mechanical (Syntron Co.)*, Mar., 145
Separator, magnetic (Dings Magnetic Separator Co.)*, Sept., 164
Servo development apparatus (Servomechanisms Inc.)*, Apr., 208
Servomotors, size determination, Nov., 125
Shaft speeds and vibrations measured with capacitance pickup, Jan., 87
Shaft, transverse vibration, June, 137
Shaper employs boring mill travel*, Feb., 148
Shear, magnetic rollers support sheet, Dec., 147
Sheave, adjustable-pitch (American Pulley Co.)*, May, 148
Sheet metal shapes, economy in design, Feb., 122
Shock absorber (Crown Mfg. Co.)*, July, 174
Shock resistance, designing for, Dec., 161
Shunt connection, permanent (U. S. Graphite Co.)*, May, 145
Solenoid, short stroke (General Electric Co.)*, Aug., 170
Sorting, remote control, May, 107
Speed control, precision, Sept., 102
Speed reducers
  clutch combination (Snow-Nabstedt Gear Corp.)*, Oct., 136
  concentric and right-angle (Falk Corp.)*, Aug., 167
  heavy-duty (Westinghouse Electric Corp.)*, Sept., 177
  horizontal, parallel shaft (De Laval Steam Turbine Co.)*, May, 142
  miniature (Metron Instrument Co.)*, Mar., 147
  miniature (Metron Instrument Co.)*, Nov., 172
  motorized (Link-Belt Co.)*, Nov., 178
  motorized (Sterling Electric Motors Inc.)*, Aug., 169
  motorized (Janette Mfg. Co.)*, Oct., 131
  parallel shaft (Falk Corp.)*, Nov., 180
  right-angle (Airborne Accessories Corp.)*, Apr., 201
  right-angle, horizontal (Falk Corp.)*, Dec., 180
  small (Winfield H. Smith Corp.)*, June, 164
  small (Universal Gear Corp.)*, Oct., 138
  torque-arm (Dodge Mfg. Corp.)*, Feb., 164
  torque-arm (Dodge Mfg. Corp.)*, Dec., 186
  varying torque and speed*, Jan., 114
  vertical (Cleveland Worm & Gear Co.)*, Mar., 145
Spinner, yarn (Saco-Lowell)*, Sept., 139
Spinner, yarn (H & B American Machine Co.)*, Sept., 138
Splined connections, torque capacity, Mar., 143
Springs, determining maximum energy, Mar., 129
Springs, helical (Data Sheet), Dec., 173
Springs, minimum solid height, Aug., 184
Sprocket, modified tooth form (Chain Belt Co.)*, Feb., 168
Starters
  a-c magnetic (Square D Co.)*, Jan., 134
  a-c magnetic (Ward Leonard Electric Co.)*, June, 166
  a-c- magnetic (Arrow-Hart & Hegeman Electric Co.)*, July, 174
  a-c magnetic (Furnas Electric Co.)*, July, 169
  a-c magnetic (Westinghouse Electric Corp.)*, June, 160
  a-c magnetic (Allen-Bradley Co.)*, Feb., 154
  engine, torque limiting mechanism*, Jan., 132
  manual (Westinghouse Electric Corp.)*, Apr., 202
  manual (Westinghouse Electric Corp.)*, Dec., 186
  manual, autotransformer (Allen-Bradley Co.)*, Jan., 133
Straight-line linkage motion, Jan., 90
Stamped parts, design details, Dec., 157
Statistical analysis applied to production machines, Jan., 72
Stress analysis, torsional shear, bars, July, 120
Styling
  automotive, Jan., 158
  automotive, Apr., 256
  machine tools*, Dec., 177
  trends, Nov., 146
  vacuum cleaner, May, 108
Switches
  cartridge type, hydraulic pressure (Pantex Mfg. Corp.)*, Sept., 172
  cycling, regulation of heating system, June, 128
  electronic, time (Henry G. Dietz Co.)*, July, 167
  front-operated, safety (Federal Electric Products Co.)*, May, 150
  magnetic proximity (Jo-Bell Products Co.)*, May, 148
  momentary contact (Ark-Less Switch Corp.)*, Mar., 152
  momentary contact (Micro Switch)*, Apr., 199
  precision, splashproof (W. L. Maxson Corp.)*, July, 168
  pressure actuated (Meletron Corp.)*, May, 152
  pressure differential (Barksdale Valves)*, Nov., 172
  pressure, vacuum (Fasco Industries Inc.)*, Mar., 148
  rotary, snap (Ark-Less Switch Corp.)*, Aug., 167
  snap-action (Acro Mfg. Co.)*, Oct., 138
  snap-action (Comar Electric Co.)*, Aug., 168
  snap-action (Exhibit Supply Co.)*, Sept., 170
  snap-action, miniature (Micro Switch)*, Apr., 201
  snap-action, precision (W. L. Maxson Corp.)*, Mar., 156
  snap-action, precision (W. L. Maxson Corp.)*, May, 147

T

Tachometers
  electric, hand (Metron Instrument Co.)*, Sept., 178
  electric, high-speed (Chicago Electric Tachometer Co.)*, Apr., 201
  electric, portable (Electric Tachometer Corp.)*, Jan., 140
  electronic (Potter Instrument Co.)*, Oct., 140
Television, industrial (Radio Corp. of America)*, July, 176
Tension control*, May, 93
Testing
  audio signal meter (International Instruments Inc.)*, Dec., 186
  automotive brake linings*, June, 123
  cell, standard, electronic (Hastings Instruments Co.)*, Jan., 142
  dual-wheel rotary abrasion tester*, Oct., 118
  dye process for fracture analysis*, Sept., 109
  dynamic strain amplifier (Baldwin Locomotive Works)*, July, 176
  dynamometers, traction type (W. C. Dillon & Co.)*, Mar., 158
  film thickness measure (Henry A. Gardner Laboratory Inc.)*, July, 176
  fuel injection rate analyzer, Oct., 95
  generator, double pulse (Berkley Scientific Co.)*, Sept., 178
  hydraulic machine controls loading, Aug., 116
  monel plastic deformation by polarized light*, May, 92
  oscillograph (Consolidated Engineering Corp.)*, Dec., 188
  oscillograph (Sound Apparatus Co.)*, Dec., 188
  oscilloscope, torsional vibration in rotating shaft*, May, 160
  oscilloscope tracer (Robert A. Walters Inc.)*, Sept., 178
  polariscope (General Radio Co.)*, Dec., 188
  production testing large d-c equipment, June, 234
  shear hardness (Taber Instrument Corp.)*, May, 154
  static properties, tension tester*, Feb., 150
  strain indicator, battery-powered (Baldwin Locomotive Works)*, Apr., 208
  strain recorder (Baldwin Locomotive Works)*, Dec., 188
  surface-finish comparator (Sheffield Corp.)*, Oct., 140
  tension (All-Weather Springs)*, Dec., 188
  vibration measuring (Vibroscope Co.)*, Sept., 178
  vibration pickup, capacitance type, Jan., 87
  viscometer, torque principle, Mar., 120
Textile machinery, Sept., 130
Thermostat, a-c miniature (George Ulanet Co.)*, Jan., 135
Thermostat, bimetal (Stevens Mfg. Co.)*, June, 159
Thermostat, electric (Wilcolator Co.)*, July, 172
Thread roller employs planetary action, Dec., 146
Thread winder uses moving spindle, Dec., 150
Timers
  audible signal (Haydon Mfg. Co.)*, July, 172
  cam, recycling (Industrial Timer Corp.)*, June, 160
  double-pole switch (Walser Automatic Timer Corp.)*, June, 160
  duplex cycle (R. W. Cramer Co.)*, Sept., 172
  electronic (Photoswitch Inc.)*, June, 164
  hermetically sealed (A. W. Haydon Co.)*, July, 170
  industrial electronic (General Electric Co.)*, Aug., 166
  interval error indicator and recorder, Jan., 77
  recycling, tandem size (Industrial Timer Corp.)*, Mar., 147
  resetting delay (Automatic Temperature Control Co.)*, Sept., 168
Timer drive, mechanical (Pittsburgh Equitable Meter Div., Rockwell Mfg. Co.)*, Sept., 170
Timing motor, slow-speed (Haydon Mfg. Co.)*, June, 162
Toggles, determining jaw force, Mar., 104
Toggles, force multiplication mechanism*, June, 194
Toggle mechanism for automatic reversal hydraulic cylinder (Vickers Inc.)*, Oct., 148
Toggle, overcenter, circuit breaker, Jan., 100
Transformer, differential, measures mechanical displacement electrically*, Mar., 95
Transformer, standardized control (Westinghouse Electric Corp.)*, Feb., 166
Transformer, variable (Superior Electric Co.)*, Mar., 146
Transformer, variable (Superior Electric Co.)*, Aug., 169
Transmissions
  bevel gear differential*, Feb., 149
  three-speed, planetary, Oct., 116

*Denotes short articles of less than one page.

Transmissions (Continued)
two-speed (Western Mfg. Co.)*, Aug., 170
two-speed, planetary*, Aug., 196
variable-speed, (Revco Inc.)*, Jan., 133
variable-speed (Speed Selector Inc.)*, Mar., 150
variable-speed (Graham Transmissions Inc.)*, July, 166
variable-speed, automatic (Diesel Pump & Electric Mfg. Co.)*, July, 171
variable-speed, die-cast (Standard Transmission Equipment Co.)*, Feb., 154
v-belt*, Aug., 194
Tubes, bending loads, (Data Sheet), Nov., 163
Tube reducer (Parker Appliance Co.)*, June, 160
Tubing
plastic, flexible (Carter Products Corp.)*, May, 146
stainless steel, flexible (Carpenter Steel Co.)*, Jan., 135
stainless steel, flexible (Chicago Metal Hose Corp.)*, Apr., 204
stainless steel, welded (Carpenter Steel Co.)*, May, 148
Turbines, axial-flow, design charts, (Data Sheet), Apr., 195
Turbines, gas, truck*, Dec., 175
Turbines, impeller blade design, Feb., 111
Turbine, pump unit, Aug., 114
Turning and boring cutting time charts, June, 150
Typewriter mechanism, Nov., 154

U

Universal joint, sliding piston transmits torque*, Mar., 176
Universal joint (Boston Gear Works)*, Nov., 178
Universal joint, full-sealed (Blood Bros. Machine Co.)*, Feb., 164
Universal joint (Universal Products Co. Inc.)*, Oct., 146
Unpacker, high-speed, July, 134

V

Valves
angle (Hammel-Dahl Co.)*, Oct., 134
angle needle (Kohler Co.)*, Feb., 160
air control (Logansport Machine Co.)*, July, 168
air control (Scovill Mfg. Co.)*, Sept., 174
air control (Valvair Corp.)*, July, 174
air control (Scovill Mfg. Co.)*, Feb., 168
air control (Foxboro Co.)*, Feb., 166
air control (Mechanical Air Controls Inc.)*, Jan., 138
air control (Ross Operating Valve Co.)*, Sept., 174
air control (Mechanical Air Controls Inc.)*, Oct., 132
air control (Scovill Mfg. Co.)*, May, 150
air control (Hannifin Corp.)*, Feb., 164
air control (Beckett-Harcum Co.)*, Feb., 162
air hydraulic control (Hanna Engineering Works)*, Nov., 174
air-hydraulic, solenoid (C. B. Hunt & Son Inc.)*, Apr., 204
air, solenoid (Square D Co.)*, Aug., 166
air, solenoid (Ross Operating Valve Co.)*, Feb., 155
air, solenoid (Galland-Henning Mfg. Co.)*, Apr., 202
air, time delay (Ross Operating Valve Co.)*, May, 143
conical rotary*, Dec., 202
control, design and selection, Sept., 153
cylinder, high-pressure (Airmatic Valve Inc.)*, June, 166
differential type relief (Hydraulic Equipment Co.)*, Mar., 156
flow control (Pneu-Trol Devices Inc.)*, Aug., 172
fluid control (Valvair Corp.)*, Nov., 176
fluid, midget (Automatic Switch Co.)*, Dec., 178
fluid, solenoid (Charles Englehard Inc.)*, Apr., 199
fluid, solenoid (Electrol Inc.)*, June, 168
gate, lightweight (Parker Appliance Co.)*, Mar., 150
hydraulic, ball seats on rotary control shaft*, July, 182
hydraulic, controls pressure applied to blade of metal cutting saw, Mar., 116
hydraulic, four-way (Rivett Lathe & Grinder Inc.)*, Aug., 172
hydraulic and pneumatic, four-way (Barksdale Valves)*, Sept., 172
hydraulic, relief, Mar., 121
hydraulic relief (Pantex Mfg. Co.)*, May, 147
high-velocity, solenoid (Johnson Corp.)*, Apr., 201
liquefied petroleum-gas (Crane Co.)*, Apr., 200
relief (A. W. Cash Valve Mfg. Corp.)*, Aug., 174
rubber pinch (United States Rubber Co.)*, June, 162
shutoff, safety (North American Mfg. Co.)*, Jan., 138
shuttle, high-pressure (Parker Appliance Co.)*, Jan., 137
spring loaded dumping*, June, 194
temperature control (Sterling Inc.)*, Dec., 184
throttling, venturi ball (W-K-M Co.)*, Sept., 166
vacuum (F. J. Stokes Machine Co.)*, Nov., 174
vent and drain (Crane Co.)*, June, 164
Vibrators
conical pendulum*, Feb., 192
pneumatic (Cleveland Vibrator Co.)*, Nov., 170
pneumatic (SPO Inc.)*, Aug., 168
pneumatic (SPO Inc.)*, Oct., 131
Vibrations, transverse, loaded shafts, June, 137
Vibrations, velocity pickup*, Dec., 119
Voltmeter (General Electric Co.)*, Dec., 182

W

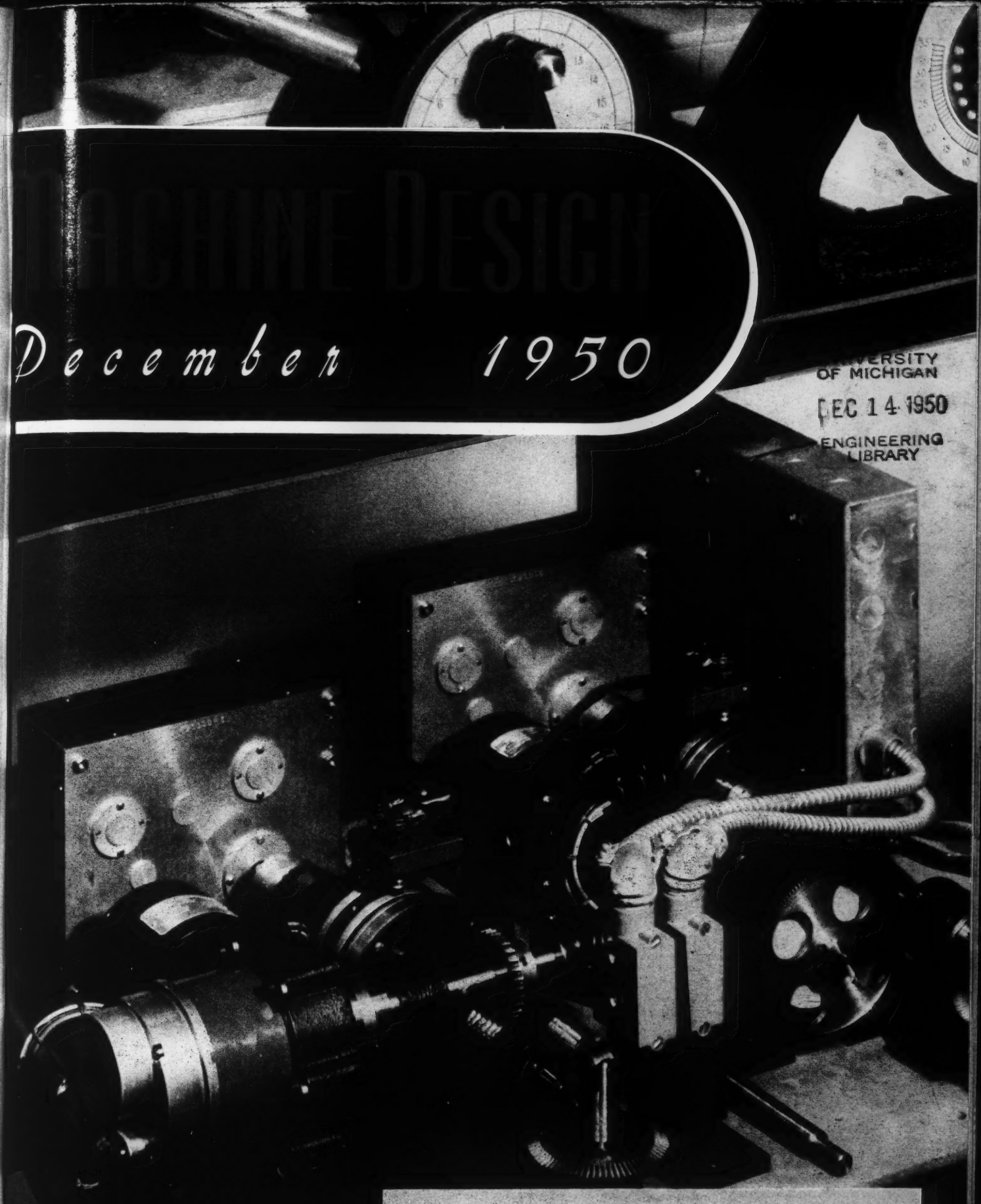
Washer, split thrust (Saginaw Bearing Co.)*, Mar., 152
Wattmeter (General Electric Co.)*, Nov., 178
Welding stud, arc (KSM Products Inc.)*, Nov., 172
Weldments, large, design of, Dec., 168
Wheels
disk, industrial (Geneva Metal Wheel Co.)*, June, 159
heavy-duty (Aerol Co.)*, Apr., 199
industrial (Aerol Co.)*, Sept., 166
industrial, pneumatic (Aerol Co.)*, Feb., 160
Whiteprinter (Charles Bruning Co.)*, Jan., 142
Whiteprinter (Peck & Harvey)*, June, 170
Wiper, metallic rod (Hydraulic Accessories Co.)*, May, 146
Wire, nickel-clad copper (Sylvania Electric Products Inc.)*, May, 142
Wire, plastic insulated (William Brand & Co.)*, Mar., 154
Wrapper, automatically packages textiles*, Dec., 148

*Denotes short articles of less than one page.

MACHINE DESIGN

December 1950

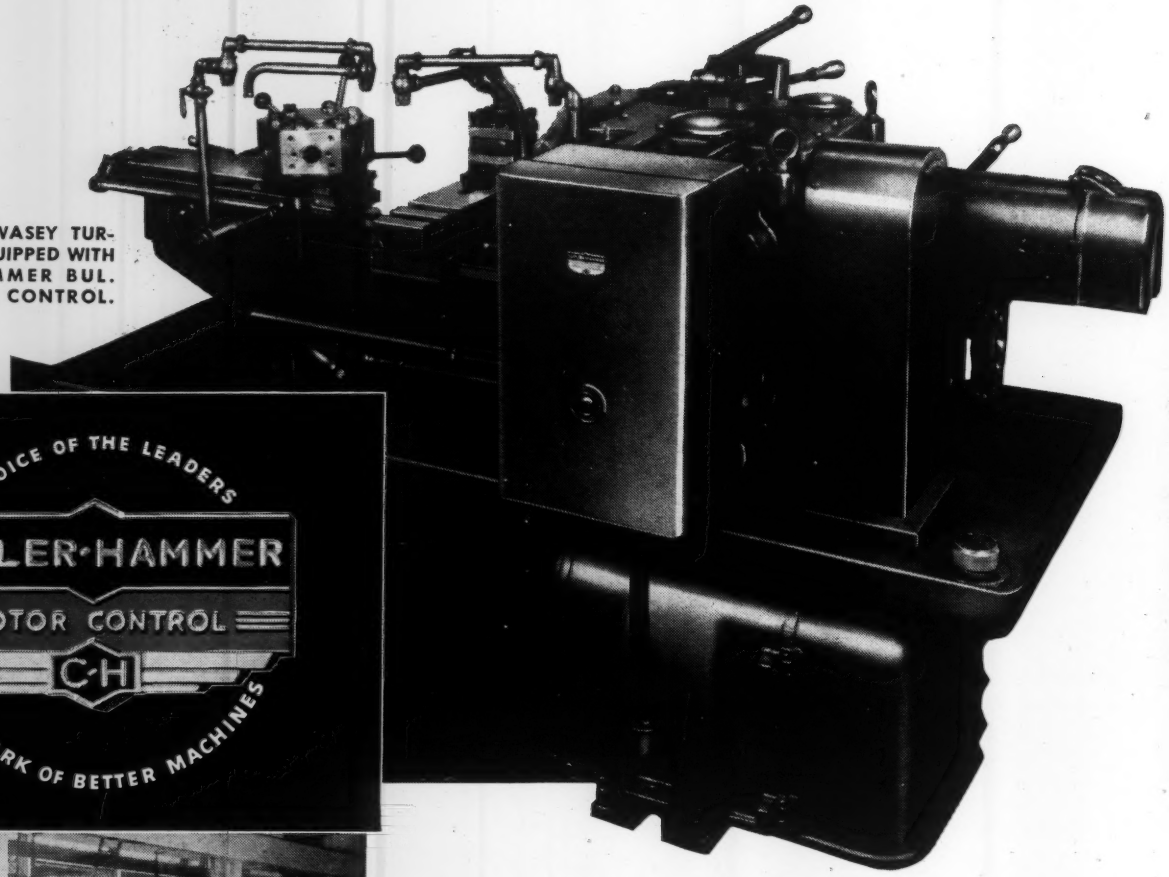
UNIVERSITY OF MICHIGAN
DEC 14 1950
ENGINEERING LIBRARY



In This Issue:

PHOTOELASTICITY
WHY PARTS FAIL
SHOCK RESISTANCE
DESIGN FOR SAFETY
SYSTEMATIC DESIGN
STAMPED PARTS
HELICAL SPRINGS

Contents, Page 3



WARNER & SWASEY TURRET LATHE EQUIPPED WITH CUTLER-HAMMER BUL. 9739 MOTOR CONTROL.

CHOICE OF THE LEADERS

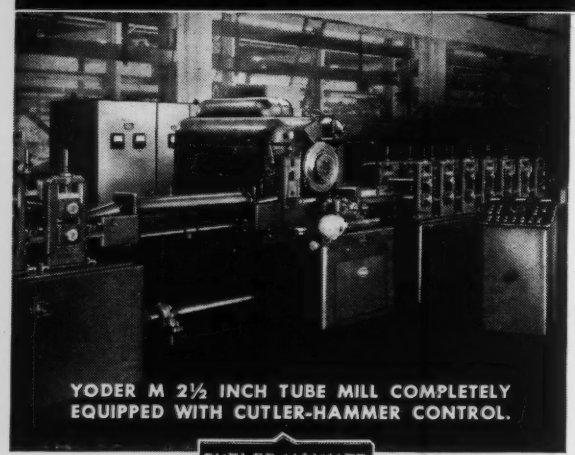
CUTLER-HAMMER

MOTOR CONTROL

C-H

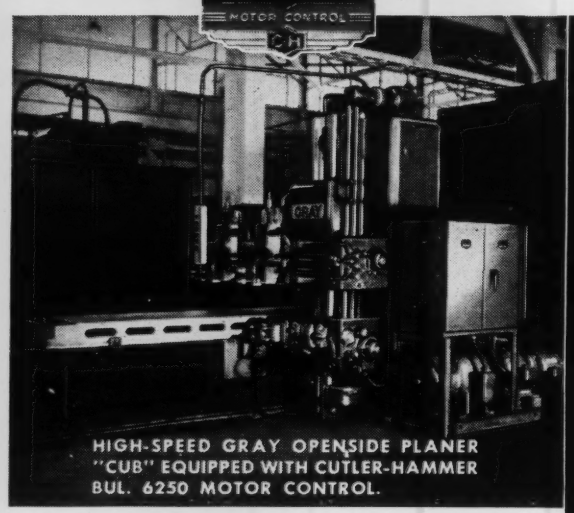
THE MARK OF BETTER MACHINES

Command Performance

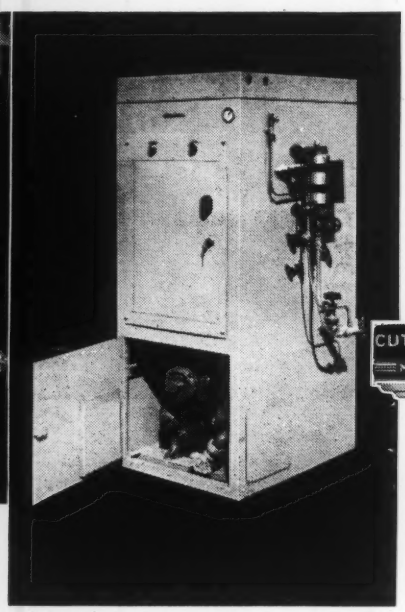


YODER M 2½ INCH TUBE MILL COMPLETELY EQUIPPED WITH CUTLER-HAMMER CONTROL.

Among the numerous manufacturers of every type of machine made are always a certain few recognized leaders who have won success by the excellence of their product. Basic to such excellence, of course, is good engineering. And good engineering invariably means the utmost discrimination in the selection of any purchased components. There in one, two, three order is the reason why Cutler-Hammer Motor Control is so frequently the repeated selection of outstanding machine builders. Able engineers respect able engineering. And that is why Cutler-Hammer Motor Control is so widely accepted as the mark of better machines. CUTLER-HAMMER, Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.



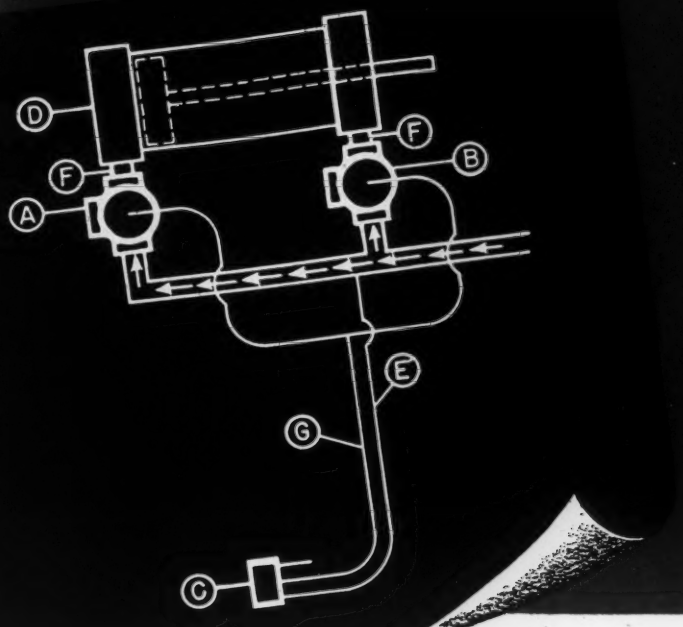
HIGH-SPEED GRAY OPENSIDE PLANER "CUB" EQUIPPED WITH CUTLER-HAMMER BUL. 6250 MOTOR CONTROL.



CUTLER-HAMMER MOTOR CONTROL C-H

ALL-ELECTRIC AUTOMATIC STEAM GENERATOR MADE BY THE CUSTOM ENGINEERING COMPANY, CUTLER-HAMMER CONTROL AND CUTLER-HAMMER TUBULAR HEATING UNITS ARE STANDARD EQUIPMENT.

How to Boost Production with new Method of Mounting Row Valves



★ Faster Machine Speeds

★ Less Air Consumption

★ Economical Installation

★ Easier Operation

Close-coupling of valve to cylinder! That's the story behind the remarkable success of the *new Ross In-Line Master Valve.*

Users claim several important advantages. By placing the master valves (A & B) at the cylinder (D), air supply and exhaust are speeded up appreciably. This in turn permits faster movement of the cylinder piston and materially increases production.

At the same time, the close coupling means that two lengths of large diameter piping between valve and cylinder—pipes continually filled and exhausted with non-productive air—are replaced by two short connecting pipes (F). The resultant saving in air with every movement of the piston considerably reduces operating costs.

Operation is by a small, conveniently located 3-way pilot valve (C). It is supplied through tubing (E) and connected to the master valves by tubing (G). It may be mechanically, manually or electrically controlled. Hand or foot operation is greatly facilitated by the use of the smaller, more easily actuated pilot model.

The complete story of possible advantages in *your* production will be gladly furnished without obligation. Ask for Bulletin No. 302.

Ask Ross for Any Air Control Information

Ross makes valves only — hundreds of types and sizes. Take advantage of the experience gained in over a quarter century of concentration on control and application of air power!

ROSS OPERATING VALVE COMPANY

Air Control

120 E. GOLDEN GATE AVE., DETROIT 3, MICHIGAN

Chances are

you now depend on C/R

Of all the automobiles on today's highways, a majority are equipped with C/R Oil Seals. In the car you drive, chances are C/R Seals help to guarantee you a smooth, trouble-free ride. Similarly, you'll find C/R Oil Seals delivering dependable service in many other kinds of mechanical equipment. If you are not already using C/R Oil Seals in your product, it will pay you to check on the reasons for C/R's outstanding dependability.

Every C/R Oil Seal is produced through careful study of all the operating conditions involved. Before a recommendation is made, the design and sealing member are given special consideration. IN MANY APPLICATIONS, LEATHER IS STILL A MOST EFFECTIVE SEAL. IN OTHERS, A SPECIAL SYNTHETIC RUBBER SEALING ELEMENT IS REQUIRED. C/R engineers have had long leadership experience in the manufacture of industrial leathers, and in pioneering the development of synthetic rubber. That's why they are qualified to select the seal which will assure you dependable operation.

ENGINEERS: We will be pleased to send you engineering data on "Perfect" Oil Seals on receipt of your written request.

For over thirty years, Chicago Rawhide has been the world's largest manufacturer of shaft type oil seals. More than 16 standard types and 1800 sizes have been developed. If your product requires a special seal, C/R will create it for you. You can depend on the quality and performance of C/R Oil Seals.

Chicago Rawhide engineering service is always available for the solution of your particular sealing problems.

CHICAGO RAWHIDE MANUFACTURING CO.

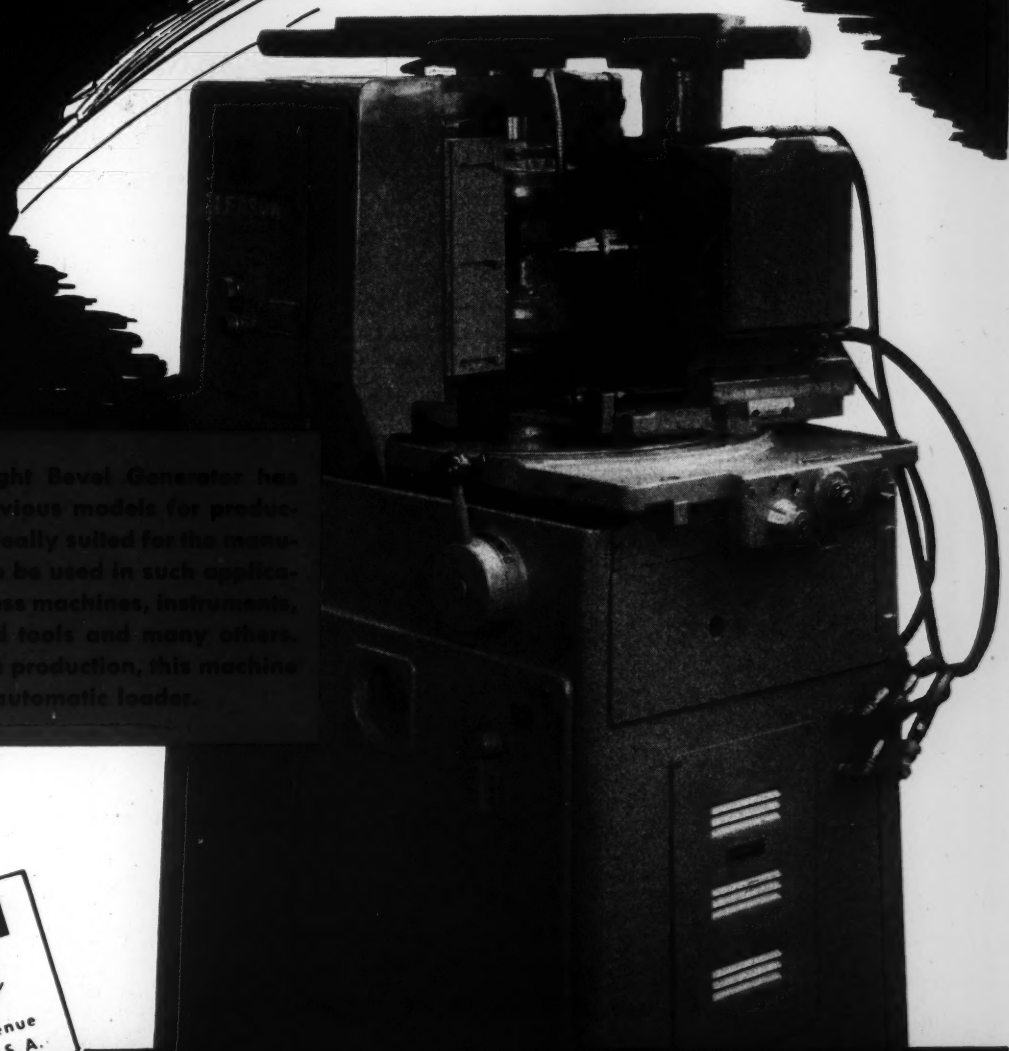
1304 Elston Avenue **OIL SEAL DIVISION** Chicago 22, Illinois

Chicago Rawhide Manufacturing Company specializes in mechanical sealing and protective products: oil seals and special diaphragms, boots, gaskets, washers and packings of *Sirvene* synthetic rubber and *Sirvis* mechanical leather.

PERFECT *Oil Seals*

SMALL CONIFLEX® GEARS

The New Gleason No. 2 Straight Bevel Generator is Gleason's answer to the ever increasing demand for Coniflex gears in the very small sizes. For here is a machine capable of faster cutting time—developed to meet the need for increased production. It incorporates the principle of interlocking disc type cutters which complete each slot from the solid in one combined roughing and finishing operation.

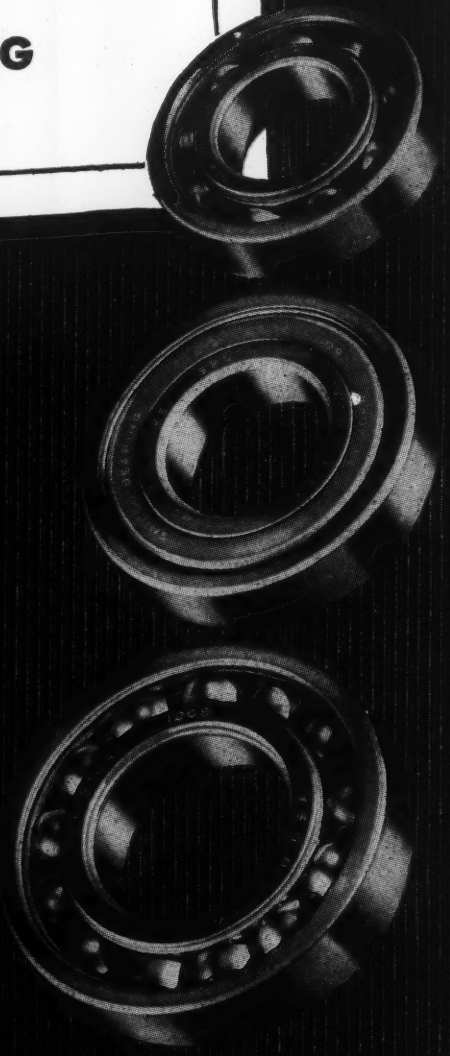


The Gleason No. 2 Straight Bevel Generator has greater flexibility than previous models for producing small size gears. It is ideally suited for the manufacture of Coniflex gears to be used in such applications as typewriters, business machines, instruments, ordnance equipment, hand tools and many others. If requirements are for high production, this machine can be equipped with an automatic loader.

GLEASON Works
1000 University Avenue
Rochester 3, N. Y., U. S. A.

Builders of Bevel Gear Machinery for Over 85 Years

Best Things in Life are Free – RUNNING



Friction has some use
but mostly it is
freedom from friction
this world needs.
In machines, that freedom is
essential to long, useful life.
Ball bearings give you most,
New Departure makes them best.

Nothing Rolls Like a Ball...

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

121

ITEMIZED INDEX

Classified for convenience when studying specific design problems

Design—General

Bearings, stepped film, Edit. 171
Machine parts, fracture analysis, Edit. 151
Mechanisms, systematic design, Edit. 126
Motion pictures, high-speed, design studies, Edit. 143
Photoelasticity, three-dimensional, Edit. 122
Safety, design for, Edit. 113
Shock resistance, design for, Edit. 161
Springs, helical (Data Sheet), Edit. 173
Stamped parts, Edit. 157
Steel, heat treatment specification, Edit. 138
Weldments, Edit. 168

Engineering Department

Equipment:
  Drafting room, Edit. 188; Adv. 216, 271, 275
  Experimental, Edit. 119, 157, 188
Management, Edit. 176
Supplies:
  Drafting room, Adv. 42, 227

Materials

Aluminum alloys, Adv. 37-40
Beryllium-copper, Adv. 71
Brass, Adv. 65, 288
Bronze, Adv. 65, 279
Carbon and graphite, Adv. 62, 200
Copper alloys, Adv. 65, 288
Friction materials, Adv. 91
Gray Iron, Adv. 100
Plastics, Edit. 184
Rubber and synthetics, Adv. 187, 218, 263, 277, 279
Stainless steel, Adv. 55, 76, 81
Steel, Edit. 138; Adv. 86, 236

Parts

Axle assemblies, Adv. 242
Bearings:
  Ball, Adv. 6, 13, 33, 41, 96, 103, 193, 196, 217, 221, 228, 251, 270
  Needle, Adv. 41, 89
  Oil-less, Adv. 206
  Roller, Adv. 13, 33, 41, 103, 193, 196, 221, 222, 235, back cover
  Sleeve, Edit. 171; Adv. 85, 92, 179, 206, 241, 248, 278
Belts, Edit. 186; Adv. 4, 18, 93
Brakes, Adv. 224, 225
Brushes, Adv. 268
Carbon and graphite parts, Adv. 62, 200, 244
Castings:
  Die, Adv. 47
  Permanent mold, Adv. 79
  Sand, Adv. 26
Chains:
  Conveyor, Adv. 52, 74, 107
  Roller, Adv. 20, 52, 73, 74, 107, 195
  Silent, Adv. 20, 52, 73, 74, 107
Clutches, Adv. 21, 50, 197, 224, 225, 237, 272
Controls (see Electric etc.)
Counters, Adv. 24
Couplings, Adv. 15, 21, 61, 73, 74, 200, 277
Drives, adjustable-speed, Edit. 184, 186; Adv. 9, 30
Electric accessories, Adv. 59, 276
Electric controls:
  Actuators, Edit. 180
  Collector rings, Adv. 274
  Contactors, Adv. 204, 211
  Control assemblies, Adv. inside front cover, 83
  Rectifiers, Adv. 59, 106
  Relays, Edit. 180, 187; Adv. 45, 49, 68, 84, 110, 185, 210, 252
  Solenoids, Adv. 59, 281
  Starters, Edit. 186; Adv. 45, 46, 58, 183
  Switches, Adv. 16, 46, 49, 270
  Thermostats, Adv. 104, 273
  Timers, Adv. 252
  Transmitter, Adv. 269
Electric heating units, Adv. 253, 273
Electric motors:
  Fractional hp, Edit. 180, 182, 184; Adv. 28, 67, 70, 88, 202, 239, 271
  Integral hp, Edit. 180, 182; Adv. 32, 59, 67, 88, 102, 202, 209, 239
  Gearmotors, Adv. 246, 283, inside back cover
  Timing, Adv. 22
  Synchro, Adv. 252
Engines, Adv. 99, 240, 268
Fasteners:
  Blind, Adv. 11
  Inserts, Adv. 280
  Locking, Edit. 180; Adv. 14, 23
  Nuts, bolts, screws, Adv. 23, 57, 190, 265, 272, 273, 276, 285, 287
  Washers, Adv. 223
Filters, Adv. 261, 269
Fittings, Adv. 44, 181
Forgings, Adv. 39
Gages, pressure, etc. (see also Instruments), Adv. 12, 44, 274
Gears, Adv. 5, 8, 34, 60, 64, 66, 78, 80, 240, 246, 278, 280
Governors, Edit. 186
Hose (see Tubing)
Hydraulic eequipment:
  Accumulators, Adv. 234
  Cylinders, Adv. 109, 214, 248, 271
  Motors, Adv. 279
  Pumps, Edit. 184; Adv. 10, 232
  Systems, Adv. 9, 72
  Valves, Edit. 184; Adv. 90, 205, 230, 266
Instruments, Edit. 120, 182, 186
Joints, Edit. 204, 215
Lubrication and equipment, Edit. 178; Adv. 48, 181, 238
Machined parts, Edit. 151; Adv. 38, 244
Motors (see Electric motors)
Mountings, vibration, Edit. 182; Adv. 220
Nameplates, Adv. 281
Piping, Adv. 44
Pneumatic equipment:
  Cylinders, Adv. 98, 109, 214, 248, 271
  Motors, Edit. 182; Adv. 269
  Valves, Adv. 1, 276
Powder-metal parts, Adv. 56, 231
Pulleys and sheaves, Adv. 30, 281
Pumps (see also Hydraulic and Pneumatic), Edit. 187, 200, 202; Adv. 54, 219, 270, 272, 280
Rings, retaining, Adv. 223
Rubber and synthetic parts, Adv. 203, 218, 263, 279
Seals, packings, gaskets, Edit. 178, 182; Adv. 2, 29, 101, 189, 226, 247, 262, 275
Shafts, flexible, Adv. 278
Speed reducers, Edit. 180, 184, 186; Adv. 19, 25, 199, 212, 252, 275, 283
Springs, Edit. 173; Adv. 94, 208, 213, 229, 268, 277
Sprockets, Adv. 73
Stampings, Edit. 157; Adv. 77, 277
Transmissions, variable-speed, Adv. 30
Tubing:
  Finned, Adv. 249
  Flexible, metallic, Adv. 82, 250
  Flexible, nonmetallic, Adv. 198
  Seamless, Adv. 97, 105, 233, 245, 249
  Welded, Adv. 97, 233
Universal joints, Adv. 266
Valves (see also Hydraulic and Pneumatic), Edit. 178, 184, 202; Adv. 44, 274
Vibrators, Adv. 264
Weldments, Edit. 168; Adv. 207, 243
Wire and wire products, Adv. 194

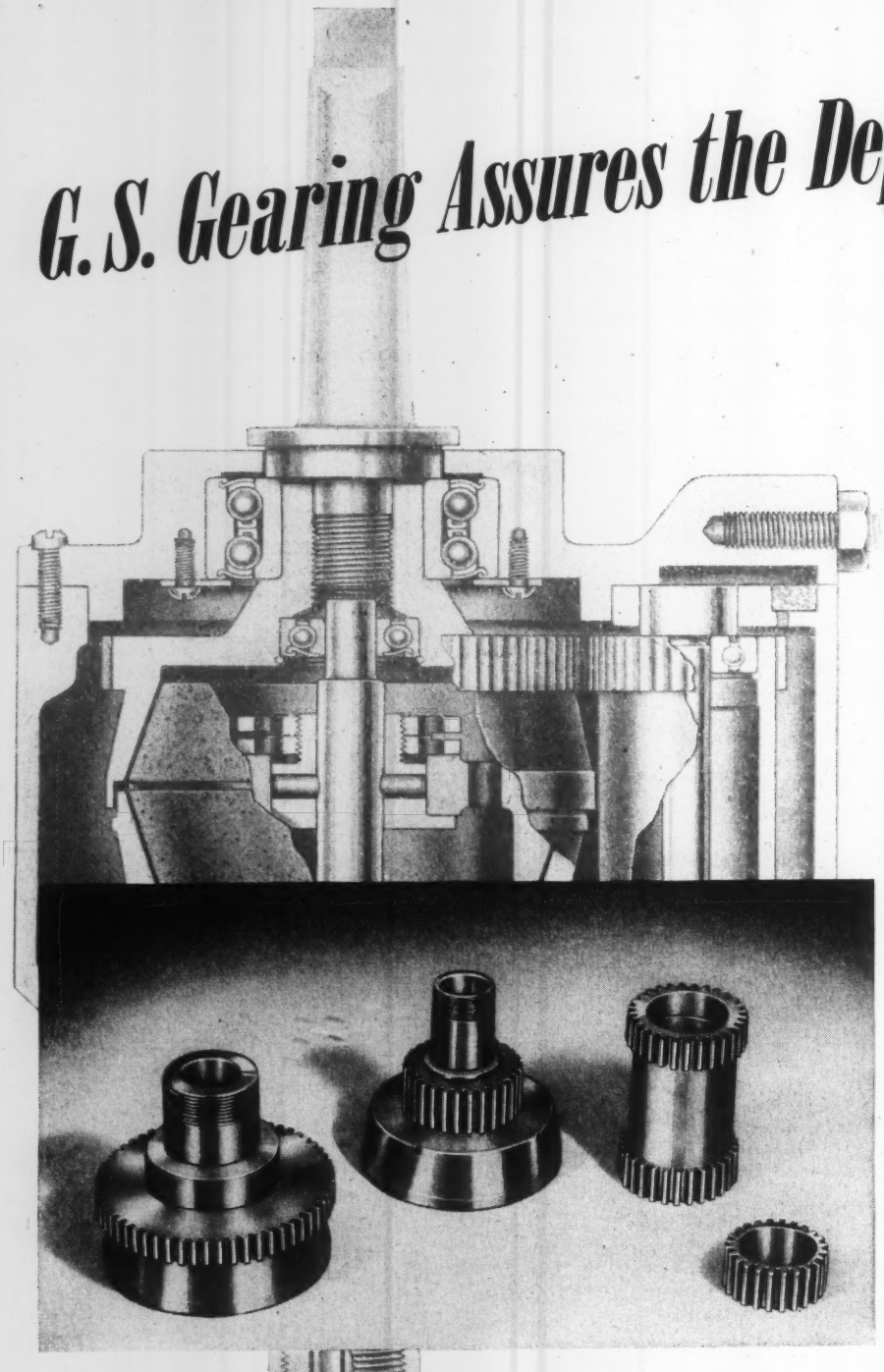
Production

Gear generator, bevel, Adv. 5
Machines, special, Edit. 146, 147, 148, 149, 150; Adv. 201
Testing and equipment, Adv. 238
Welding equipment, Adv. 51

MACHINE DESIGN is indexed in Industrial Arts Index and Engineering Index Service, both available in libraries generally.

G.S. Gearing Assures the Dependability of Snow

TAPPING, DRILLING AND THREADING EQUIPMENT



SNOW MANUFACTURING COMPANY has long enjoyed an enviable reputation for leadership in the field of Automatic Drilling, Tapping and Threading Machines. The absolute *dependability* and long life of their equipment is largely due to the consistent use of finest materials and the extreme precision with which all parts are made.

Invariably Snow specifies G.S. Fractional Horsepower Gearing for their driving mechanisms. They, like so many other leading manufacturers from coast-to-coast, have found that G.S. Gearing assures a degree of *uniform* high quality and trouble-free operation which *only these better Gears can give!*

If you have a Fractional Horsepower Gearing problem, however simple or intricate it may be, submit it to our capable staff. Get the advantage of our unusual "know-how" gained thru more than 30 years' *intensive specialization* in the design and quantity production of Gearing ranging from 12 to 96 D.P. and finer. Ideas, suggestions and moderate cost estimates won't cost you one penny. Will you write for them today?

Send for Free . .

new 6-page folder which illustrates and describes G.S. facilities, Small Gearing and applications together with handy charts for those who specify Gearing from 12 to 96 D.P. and finer. Will you ask for it on company stationery, please?

FRACTIONAL HORSEPOWER GEARING

GS

GEAR Specialties, Inc.

Spurs • Spirals • Helicals • Bevels • Internals • Worm Gearing • Racks • Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

Saves Time, Money, Material

ON CHICAGO CARTON COMPANY
LAMINATING MACHINE

AND CUT-OFF

Oilgear drive installed in 1934 operates 16 hours daily at low cost. Gives maximum production on all stocks with little spoilage or non-productive time

A laminating machine and a cut-off in the plant of the Chicago Carton Company are driven in synchronism by Oilgear Fluid Power Equipment installed in 1934. A trip to the plant reveals today the compact, sturdy Oilgear equipment on the lower floor performing quietly, efficiently and continuously 16 hours a day in the necessarily humid atmosphere. Maintenance records indicate a total expenditure of $93.21 during the 16 years for service and parts, less than $6.00 a year. Because of the full flexible speed range and easy controllability of the Oilgear drives, the laminating machine is operated at speeds that best fit the type of board being processed and the cut-off drive follows in synchronism to cut stock into uniform lengths.

Another Oilgear feature important here is the unusual speed with which the laminating machine drive and cut-off drive can be started and stopped. This feature of Oilgear smooth, high speed acceleration and quick hydro-dynamic braking reduces non-productive time and cuts spoilage of sheets to a bare minimum.

On the basis of the 16 year performance of Oilgear, the Chicago Carton Company recently installed another Oilgear drive on a new 125 hp installation.

Time after time, Oilgear demonstrates its superiority and dependability on variable speed drives. Oilgear Fluid Power has many advantages. Investigate them now. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wis.

UPPER—Oilgear 40 hp Variable Speed Drive with electric pilot motor remote control and oil reservoir base.

LOWER—Oilgear 7½ hp Variable Speed Drive with automatic control to synchronize cutter speed with speed of laminating machine drive.

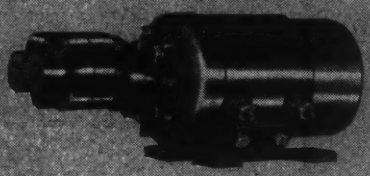
Oilgear

PIONEERS IN FLUID POWER

PUMPS, TRANSMISSIONS, CYLINDERS AND VALVES

OILGEAR

Another Job for Pesco HYDRAULIC MUSCLES



Illustrated above is a Pesco electric motor-driven hydraulic pump of the type used on smaller automatic trucks. It has a displacement of .043 cu. in. Capacity is .67 g.p.m. at 3000 p.s.i. at 33 volts D.C. and 76 amperes.

A Pesco pump is lifting this load...

IT COULD LIFT OVER TWICE AS MUCH!

Over 80,000 pounds can be lifted and transported by this die handler built by Automatic Transportation Company.

Yet the Pesco hydraulic pump that supplies the power to lift such terrific loads is so small it can be carried easily in your hand!

One important reason why more and more industrial equipment manufacturers are turning to Pesco for answers to their hydraulic power problems, is *"Pressure Loading"*. *"Pressure Loading"* is the exclusive, patented Pesco design principle that assures extremely high operating efficiencies over a long, trouble-free pump life because it *automatically* compensates for wear.

For the complete story of *Pesco Pressurized Power and Controlled Flow,* and how the sales power of Pesco hydraulic power can help you, write today.

A preliminary discussion will involve no obligation.

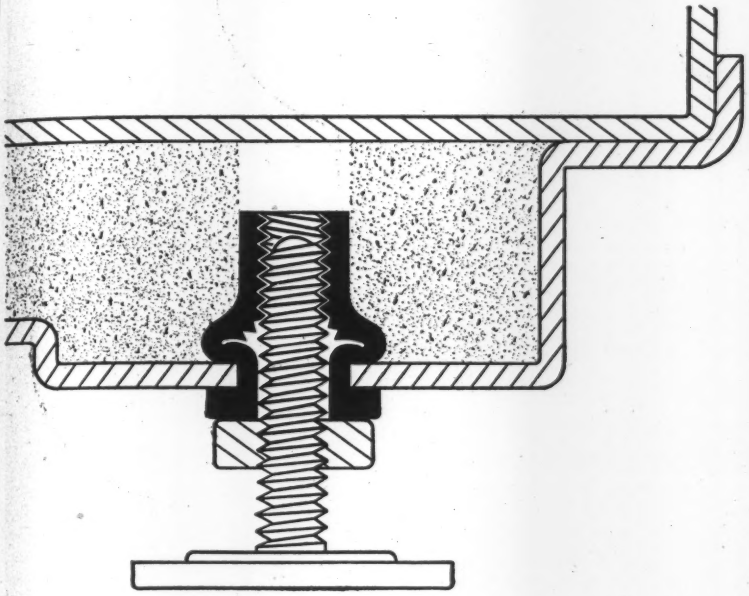
engineering Pesco production

PRODUCTS DIVISION

BORG-WARNER CORPORATION

24700 NORTH MILES ROAD BEDFORD, OHIO

RIVNUTS solve refrigerator fastening problem, cut assembly costs



REFRIGERATOR designers had a puzzler on their hands in finding a way to fasten leveling feet to the cabinet. The metal was too thin to tap, and welding would warp it. Besides, the threads would be ruined in the enameling process.

All these problems were solved by a B. F. Goodrich Rivnut—the *only* one-piece blind rivet with threads! Working from one side of the cabinet, one man installs the Rivnut in a few seconds. The easy-to-use power heading tool forms a bulge in the Rivnut shank—a "second head" that tightly grips the material. At least six threads remain clean to take the leveling-foot screw. Installation is made *after* enameling without marring the finish.

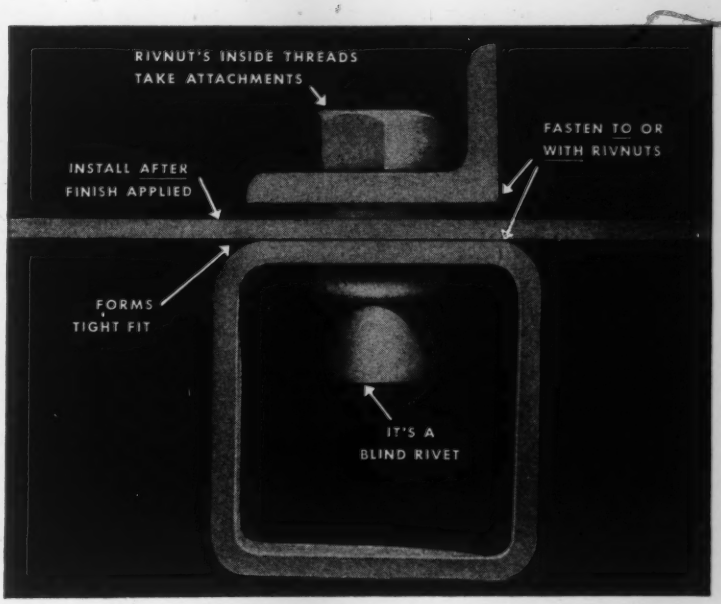
The secure fastening provided by Rivnuts improves the quality of the refrigerator. And the quick, simple Rivnut method saves many man-hours on the job, cutting assembly costs.

See an idea here for your product?

Is there a blind fastening application in your product? One where you need strong, clean threads for attachment? No other fastener can give you all the advantages of Rivnuts!

Rivnuts work in wood and plastics, as well as metal. They're available with flat head and countersunk head, in open-end and closed-end types, aluminum, brass and steel. A variety of heading tools—manual and power—is available.

For help with your fastening problems, consult a Rivnut engineer. Write to *The B. F. Goodrich Company, Department MD-120, Akron, Ohio.*



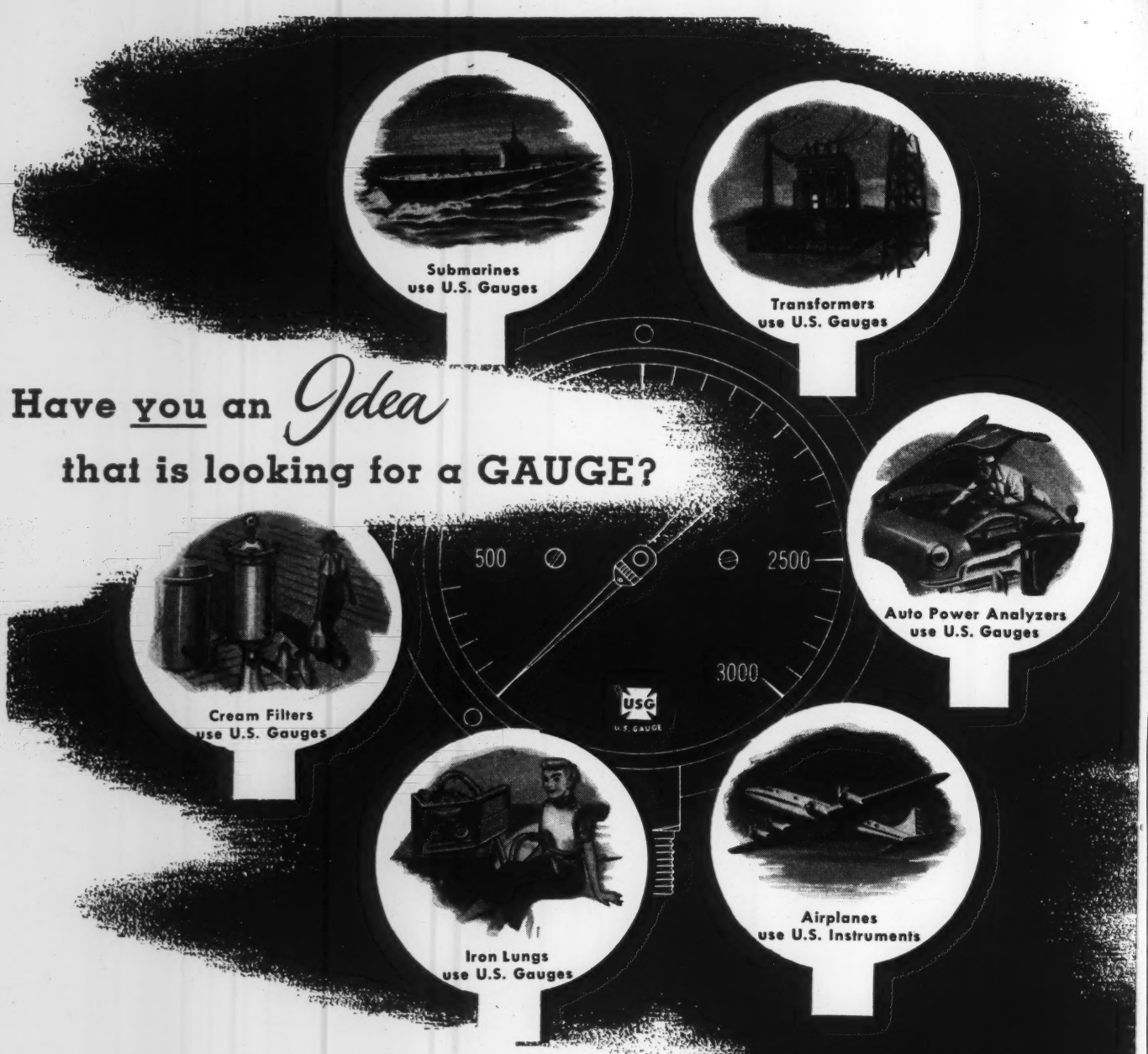
B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. For your free demonstrator, write to The B. F. Goodrich Company, Department MD-120, Akron, Ohio.



If you have an idea looking for a gauge, why not make the search short and sweet? Come to U.S. Gauge.

More than 6 out of 10 original equipment manufacturers find the solution for their problems right here in Sellersville, Pa. And for good reasons. U.S. Gauge designs and produces top-flight special purpose instruments as well as first class pressure and temperature gauges.

U.S.G. has a warm and friendly welcome for the ideas and problems of engineers and designers . . . and some solid help. Your gauge should be included in those we have developed for over 15,000 other purposes.

So whatever your gauge needs, large or small—commercial or highly specialized, call in U.S.G. *first.* United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

USG

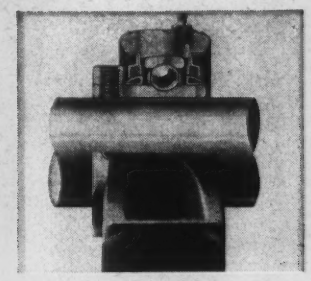
UNITED STATES GAUGE

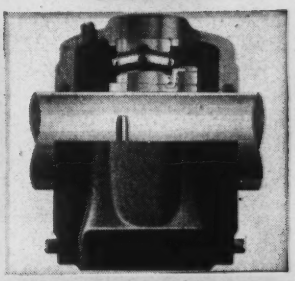
Quality Gauges Engineered for Enduring Accuracy

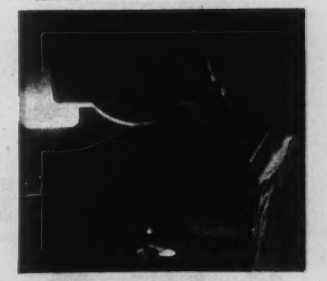
PRODUCTS OF UNITED STATES GAUGE . . . Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges

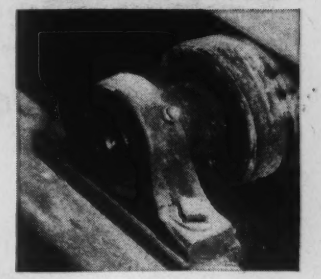
OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC., AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS.

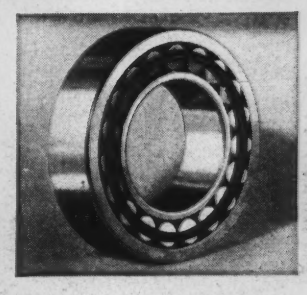
Do You have all these . . . in your bearing specifications?











secure locking

Lock a Link-Belt Ball or Roller Bearing to your shaft . . . without distortion • with firm grip • without mislocation • regardless of rotation • with wide distribution of bearing load

housing seals

LINK-BELT Ball and Roller Bearings are "housing sealed" completely . . . to assure free aligning action • to keep out dirt and moisture • to reduce wear under most severe conditions

outstanding manufacture

even by the strict standards of Ball and Roller Bearing manufacture, LINK-BELT is outstanding . . . because of the most modern precision production • because of quality control

serviceability

install LINK-BELT Ball and Roller Bearings and . . . *let 'em roll* . . .

- they are pre-lubricated • they have a large grease reservoir
- they have correct lubrication

product enhancement

gain these advantages from LINK-BELT Bearings in your product:

- dependability • alignability • high capacities
- interchangeability • quality • LINK-BELT service

a bearing for every purpose

there is a LINK-BELT Ball or Roller Bearing for . . *every* . . purpose.

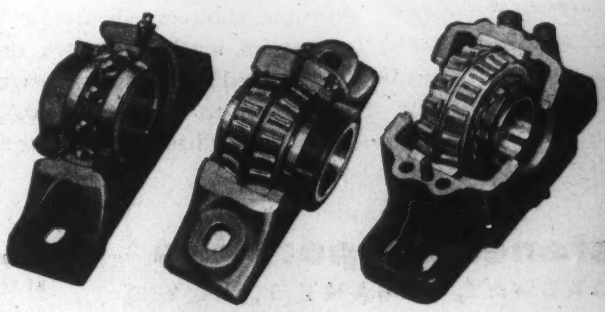
An experienced LINK-BELT bearing engineer will go over your bearing requirements with you and make recommendations, without obligation. Send for the complete new LINK-BELT Ball and Roller Bearing Catalog No. 2550.

THE SYMBOL OF QUALITY LINK-BELT

LINK-BELT COMPANY Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Minneapolis 5, Houston 1, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities.

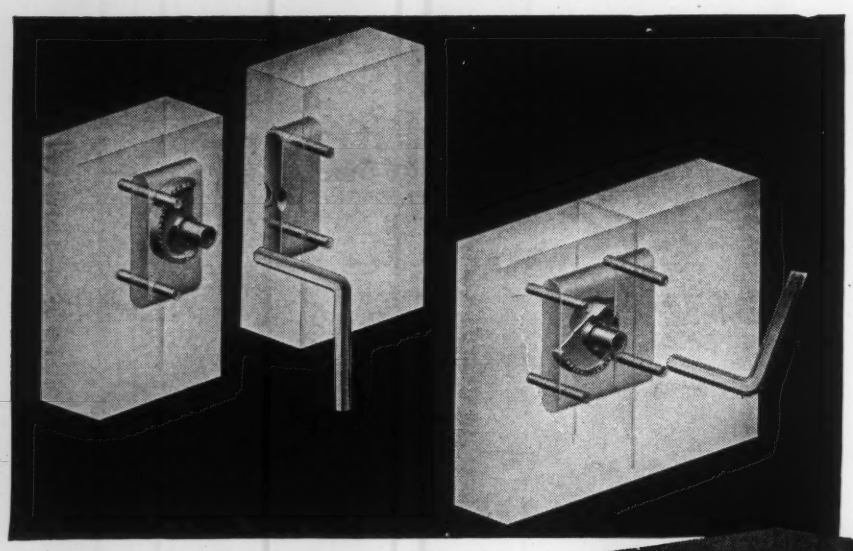
11,804

A complete line of bearings is available from stock, throughout the country, in pillow blocks, cartridge, flanged cartridge, flanged, hanger and takeup blocks —also unmounted bearings.



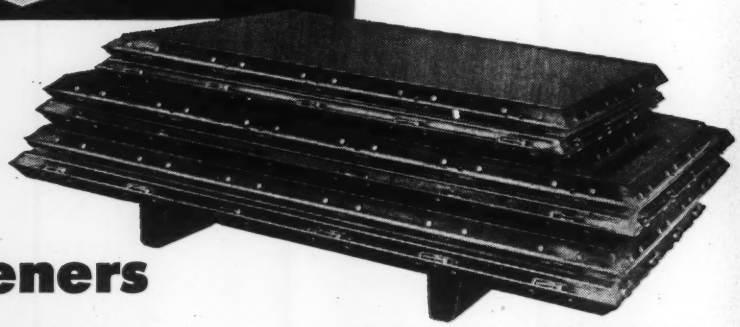
LINK-BELT

BALL & ROLLER BEARINGS



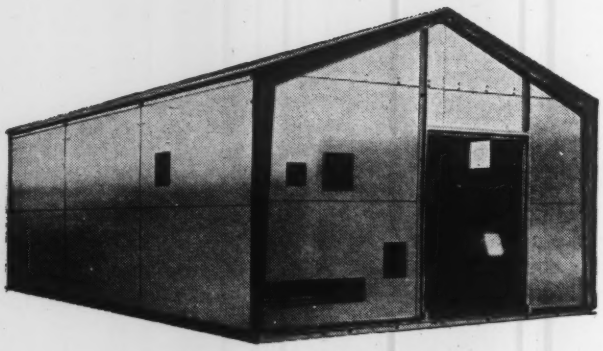
Serrated, tapered cam in male component engages lip of female. Panels are drawn tightly together when cam is turned by hex wrench, screwdriver, or any hand tool.

Lightweight air transport shipping containers, with Roto-Lock Fasteners, knock down quickly for easy return shipment.



PHOTO, COURTESY UNITED STATES PLYWOOD CORPORATION

New Roto-Lock Fasteners Solve Demountable Panel Problems



This portable shelter is made of honeycomb panels developed by the U. S. Plywood Corporation. All panels are attached with Simmons Roto-Lock Fasteners. Portable buildings are also being planned for alert hangars and maintenance hangars for fighter aircraft.

Panels of any material—equipped with the new Simmons Roto-Lock—can be fastened quickly and securely either at right angles or butt joint. No skill is required—just turn the tapered cam to lock, then turn again to unlock. Check these features of Roto-Lock...

1. Roto-Lock exerts sufficient pressure to form airtight and watertight seal when gaskets are used between panels. Carries high-tension loads as well as heavy shear loads—providing a completely structural, insulated connection.
2. Recesses completely into panels—no protruding parts.
3. Will fasten in seriously misaligned conditions—locks in any semi-open position.
4. No springs or delicate mechanical parts which may be affected by severe temperature conditions or field service.

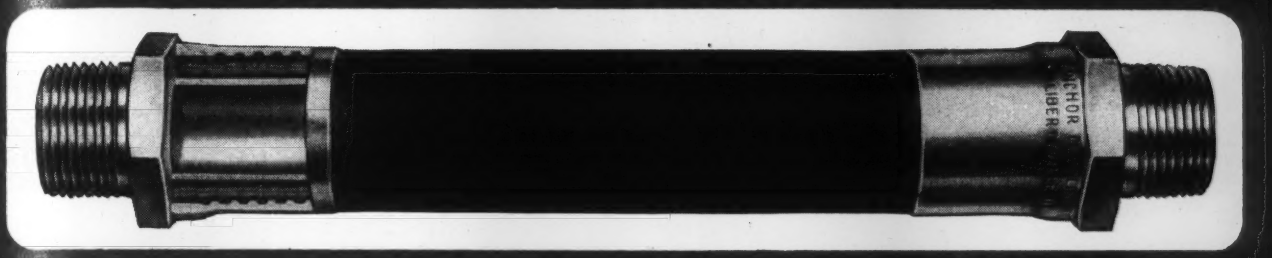
Portable shelters, air freight and cold-storage shipping containers, walk-in coolers, demountable furniture, scaffolding, and many other designs where demountability is desirable, are using this versatile fastener. All are illustrated in our literature. Write for your copy today.

Simmons Fastener Corporation
1756 NORTH BROADWAY, ALBANY 1, N. Y.

QUICK-LOCK...
SPRING-LOCK...
ROTO-LOCK...

ANCHOR

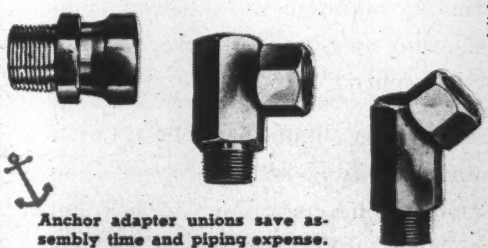
Assembled Hydraulic Hose Units



Tailor-made to Keep Your Costs Down–Performance Up

Factory-assembled to your specifications—save you time and money, give you a better job

For extra protection against leaks and blow-offs at high pressures use factory-applied Anchor Ductile Sleeve Hose Couplings with their exclusive patented grip.



Anchor adapter unions save assembly time and piping expense. Use them and other styles of related Anchor fittings to simplify your piping problems.

FOR longer service life — you design your machines with great care and manufacture them to rigid tolerances.

But the job is not done until you invest the same care in selecting and specifying hose units. After all, the performance of your machines is dependent upon them.

That's why Anchor offers factory-assembled hose units. They are made to exact lengths in accordance with your drawings. And the couplings are factory-applied by experts with specially designed machines to give you leakproof dependability and extra safety. They cost less in the long run — because they give better service, keep your customers satisfied.

Shown here is a rayon two-braid hose-assembly designed for medium and low pressures. Made from specially selected synthetic rubber, it has excellent flexibility. This same unit is also available in a single-wire braid hose.

For high pressures Anchor Ductile-sleeve hose-couplings are your best choice.

Take out performance insurance. Reduce assembly time and costs in your plant and in the field. Equip your machines with Anchor factory-assembled hose units.

Send for complete information on Anchor assembled hose units.

Tear out this coupon and mail TODAY!

ANCHOR COUPLING CO. INC.
Libertyville, Illinois

I like the dependability, the safety, and the time-and-money-saving features of Anchor Assembled Hose Units. Please send me Bulletin No. 48S.

Name..... Position.....

Company.....

Company Address.....

City..... ( ) State.....

D-2

ANCHOR COUPLING CO. INC.
Factory: Libertyville, Illinois • Branch Detroit, Michigan

MICRO SWITCH *Engineering Service* — **is geared to**

FIELD SERVICE

How MICRO SWITCH Engineers helped meet stringent switch requirements for jet-propelled Banshee fighter

DEVELOPMENT of jet-propelled aircraft has created new problems and placed new demands on materials and component parts.

Engineers of McDonnell Aircraft, St. Louis, called on MICRO SWITCH ENGINEERING SERVICE, long experienced in solving aircraft switch problems, to help them meet the stringent switch requirements for the Banshee jet-propelled Navy fighter.

MICRO SWITCH designed new dependable precision switches for control of the wing-lock mechanism as well as switches to meet other exacting requirements. The long-continued efficient operation of these MICRO products is a matter of record.

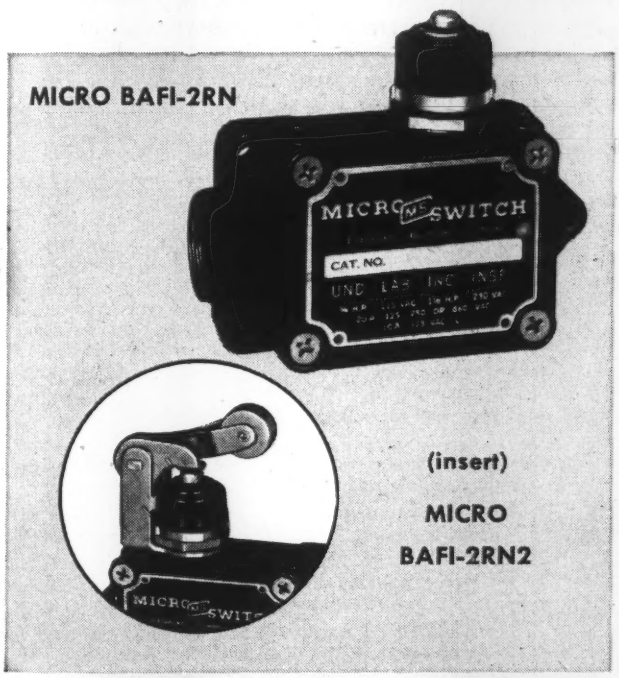
You probably don't build jet planes, but if the product you do make requires precision snap-action switches for a tough application, call on MICRO SWITCH ENGINEERING SERVICE—the service responsible for creating more than 4600 different switches for specific industrial requirements. Call or write MICRO SWITCH, Freeport, Illinois, or any of our branch offices.

tough application problems!

PRODUCT DEVELOPMENT

ADAPTABILITY STANDARDS

An ideal high-capacity MICRO precision switch to handle high inrush current!



These high-capacity switches (with either plunger or roller arm actuators) are designed to handle the high inrush current required in operation of solenoids, motors and tungsten lamps.

They are ruggedly housed and sealed to resist entrance of dirt, dust, oil and moisture.

They are Underwriters' Laboratories listed for 1½ HP motor, 230 volts a-c; ¾ HP motor, 115 volts a-c; 20 amperes, 125, 250 or 460 volts a-c; tungsten lamps, 10 amperes, 125 volts a-c. Rated for 75 amperes inrush capacity at voltages up to 460 volts a-c.

The MICRO BAFI switches are typical of MICRO SWITCH's continuing development of new precision switches to meet the ever-widening needs of design engineers.

MICRO SWITCH ENGINEERING provides just the right actuator type for every design need

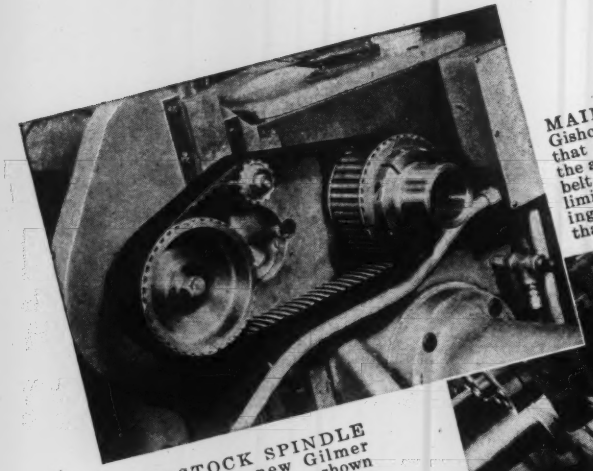
1. **PIN PLUNGER** where accurate repetition of operating point is a prime requisite.
2. **"S" PLUNGER** for application where travel of actuating device is less accurately controlled.
3. **"D" PLUNGER** large diameter plunger to facilitate operation by slow-moving cams.
4. **"Q" PLUNGER** for manual or mechanical push-button switches to be mounted through panel.
5. **LEAF ACTUATOR** for use by operating means which combine small force with limited overtravel.
6. **ROLLER LEAF ACTUATOR** suited for actuation by clock motors and other low-energy means.
7. **"W" LEVER** designed for operation by slow-moving cams or slides and similar actuating means.
8. **"W2" ROLLER LEVER** with roller assembly at lever tip . . . for fast-moving cam actuation.
9. **"W22" ROLLER LEVER** for actuation by fast-moving cams where compactness is an important factor.

MICRO...first name in precision switches

MICRO MS SWITCH
TRADE MARK ®
DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.
FREEPORT, ILLINOIS, U. S. A.

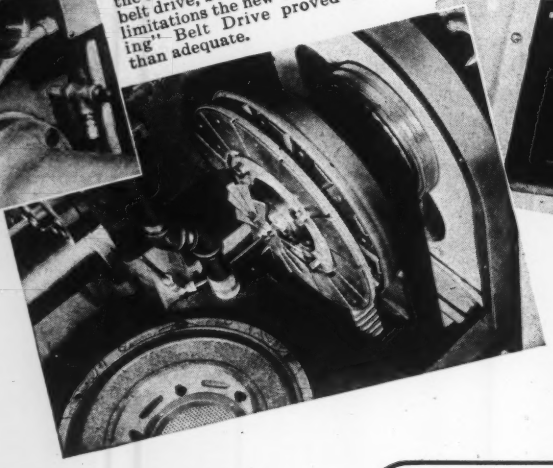
Branch offices in principal cities of the United States and Canada

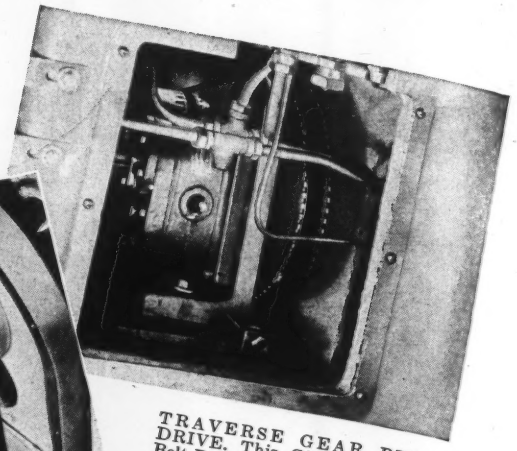
Copr. 1950, Minneapolis-Honeywell Regulator Co.



HEADSTOCK SPINDLE DRIVE. The new Gilmer "Timing" Belt Drive as shown above enables Gisholt to cover a considerable range by simply varying the number of teeth on driving or driven pulley and compensating with idler.

MAIN SPINDLE DRIVE. Gisholt design engineers found that an electric brake decreased the available room for a standard belt drive, but despite these space limitations the new Gilmer "Timing" Belt Drive proved more than adequate.





TRAVERSE GEAR PUMP DRIVE. This Gilmer "Timing" Belt Drive operates the gear pump, which maintains pressure in the hydraulic cylinders actuating the traverse mechanisms. Because the Gilmer "Timing" Belt makes positive contact with the pulleys, all slippage due to the presence of oil is eliminated.

GISHOLT solves design problems with the revolutionary, tooth-grip GILMER "TIMING" BELT* DRIVE

Here's the most revolutionary idea to hit belt drives in years! It's the tooth-grip Gilmer "Timing" Belt Drive—running in axial grooved pulleys—the only belt that makes positive engagement with the pulleys. No slip . . . no creep . . . no stretch! This tooth-grip belt has steel cables imbedded in Neoprene for greater pulling power. Provides the answer to many tough design problems.

For instance, in the production of the No. 12 Hydraulic Automatic Lathe, the design engineers of the Gisholt Machine Company in Madison, Wisconsin, were confronted with the following problems:

1. A single drive to operate the spindle from 400 to 1600 r.p.m., which previously had only been accomplished by a combination of gears or belts.

2. Space limitations.

3. Belt slippage caused by oil.

The Gilmer "Timing" Belt Drive accomplished all this, plus the elimination of an auxiliary electric motor (for the Multiple V-belt Drive) when the higher spindle speeds were required.

This was not surprising, in view of the unique features of the Gilmer "Timing" Belt Drive. It is efficient up to speeds of 15,000 f.p.m. What's more, extreme ratios are practical, so that the Gilmer "Timing" Belt Drive takes advantage of space limitations. And belt slippage is eliminated altogether, because of the "Timing" Belt's tooth-grip construction.

Many other engineers have discovered the same thing as those at Gisholt: Gilmer's "Timing" Belt Drive helps to streamline their designs. It can improve yours, too. Check this belt's many advantages listed at the right for the solution to YOUR design problem.

*Patented

Gilmer also manufactures: V-belts, flat belts, round belts, fan belts — and many others, both endless and connector types.

Only the tooth-grip Gilmer "Timing" Belt can offer all these amazing features

1. COMPLETELY POSITIVE DRIVE. The only belt that makes positive engagement with the pulleys. Teeth and groove engagement of belt with pulleys eliminates slip, creep, speed variation.

2. PRECISION TIMING. Speeds of driver and driven pulleys synchronize perfectly, guaranteeing uniform r.p.m. every moment of operation.

3. NO STRETCH. Steel cable pulling element eliminates elongation.

4. LOW OR HIGH SPEEDS. Efficient for low speeds at inches per minute, or high speeds up to 15,000 f.p.m.

5. FIXED CENTERS—NO ADJUSTMENTS. Wire cable construction permits belts to operate on fixed centers without take-up adjustments.

6. NO INITIAL TENSION. Belt does not depend on initial tension. This results in high efficiency and extremely low bearing pressure.

7. HIGH TENSILE STRENGTH. Steel cables give belt greater pulling power. Size of belt can be varied to provide for any horsepower requirements.

8. LOW OPERATING NOISE LEVEL. Tests prove the "Timing" Belt Drive quieter than precision gears running in an oil bath.

9. NO LUBRICATION. Belt requires no lubrication or dressing. Oil, however, does not harm the belt.

10. COMPACTNESS. Substantial space saving is general on Gilmer "Timing" Belt Drive applications. Extreme ratios are practical.

11. SMALL PULLEY DIAMETERS. Belt's extreme flexibility permits pulley diameters as small as ½" at 10,000 r.p.m.—even with a comparatively heavy load.

12. ECONOMICAL. Maintenance cost is low because of absence of take-up from stretch, elimination of lubrication, infrequent replacements and elimination of power waste. Moreover, initial cost may be lower than for other types of drives because of smaller drive dimensions.

13. VERSATILE. Belt can be used as a power transmission belt, timing part, or other functional part.

Gilmer BELTS

Gilmer has the PULL!

L. H. GILMER COMPANY, 1203 Tacony, Philadelphia 35, Pa. Division of United States Rubber Company

Let us help you solve your SPEED REDUCER PROBLEMS

Farrel speed reducers have incorporated in them the experience gained in the solving of innumerable problems requiring considerable pioneering in gear engineering. The result is a wide range of types (a few of which are illustrated here), that are standard in principal features, but adaptable in critical detail.

All units are supplied with precision gears, generated by the famous Farrel-Sykes process for smooth, quiet, efficient power transmission; shafts and bearings factored to safeguard against interruption of vital processes; gear cases proportioned to withstand repeated heavy peak loads; joints sealed to prevent entrance of dust and dirt.

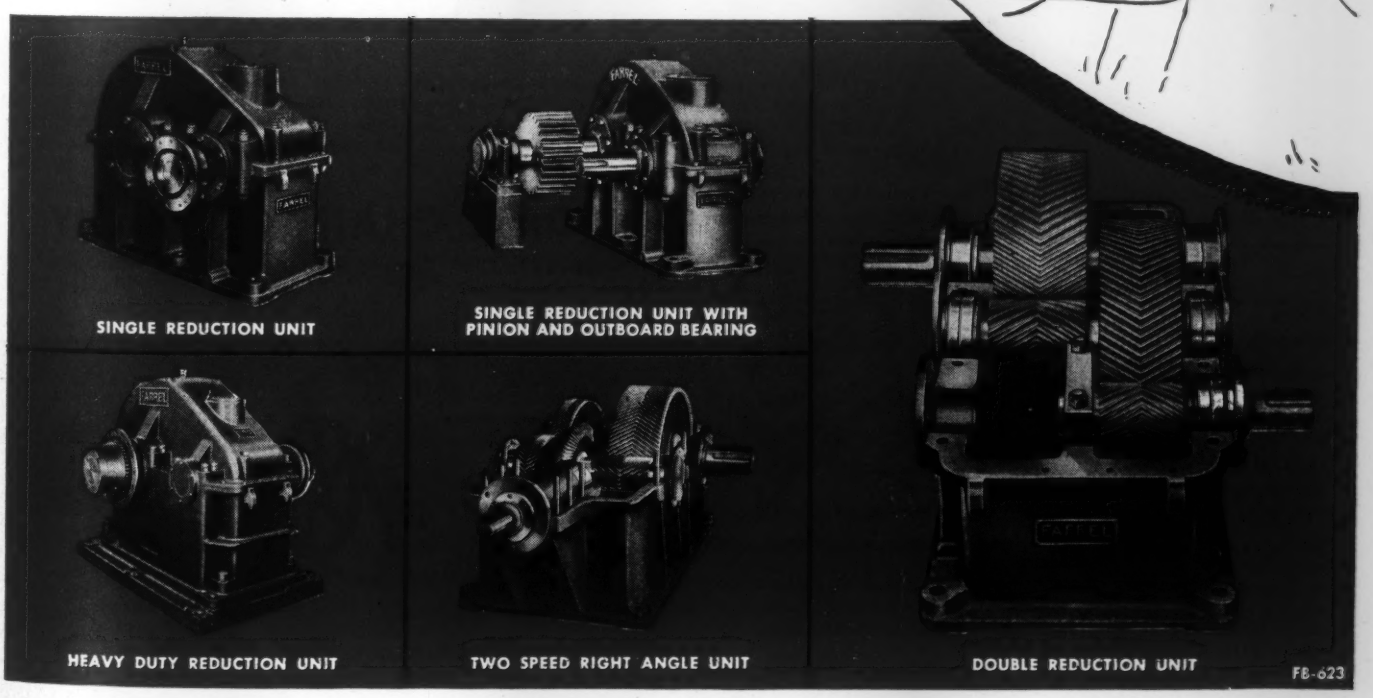
But, that is not all. Without sacrificing the advantages of general standards, the design of these units permits an engineering freedom in proportioning gears, shafts, bearings and even some housing dimensions to meet specific load, speed and service requirements. This flexibility has resulted in the solution of innumerable application problems.

Write for further details. Ask for a copy of Bulletin 449 —no cost or obligation.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y., *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Cincinnati, Detroit, Chicago, Los Angeles, Tulsa, Houston, New Orleans

Farrel-Birmingham®

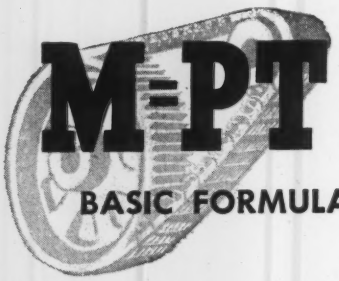

SINGLE REDUCTION UNIT
SINGLE REDUCTION UNIT WITH PINION AND OUTBOARD BEARING
HEAVY DUTY REDUCTION UNIT
TWO SPEED RIGHT ANGLE UNIT
DOUBLE REDUCTION UNIT
FB-623

for hauling CEMENT or designers rely on MORSE

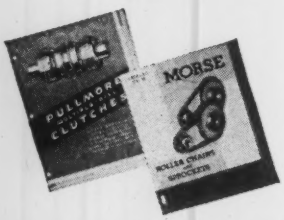
Furnishing candy for the nation's sweet tooth and handling heavy materials like cement are activities that call for machines that are entirely different. But designers of equipment for both types of jobs have chosen Morse Power Transmission Products for performance and dependability. In its Moto-Bug power wheelbarrow, the Kwik-Mix Company uses a Morse-Rockford Double Pullmore Clutch and a Morse Roller Chain Drive to the front wheels. The Currie Manufacturing Company uses three sizes and dozens of feet of Morse Roller Chain in its labor-saving, automatic starch tray stackers and feeders for candy makers.

Morse—Unlimited in Applications

Whatever your mechanical power transmission needs—for clutches, for precision-made roller or silent chain or sprockets, for couplings or drive shafts—Morse can fill them. Morse engineers' wide experience in solving power transmission problems for almost every industry, and Morse's long record of producing a great variety of the finest mechanical power transmission equipment are your assurance that M=PT, Morse *means* Power Transmission.



Morse *means* Power Transmission



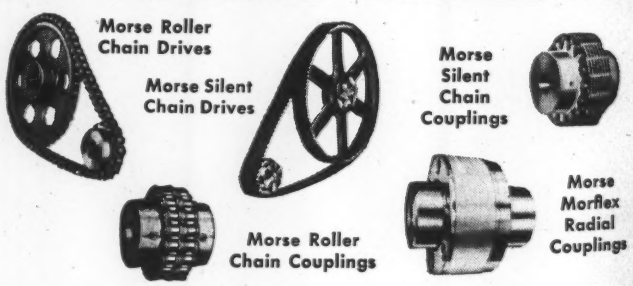
For more complete information about Morse Roller Chains and Sprockets, write today and ask for Catalog C51-50. For the full clutch story, ask for Pullmore Clutch catalog.

Ask the Morse Man for power transmission information!

MORSE CHAIN COMPANY
Dept. 581, 7601 Central Avenue, Detroit 8, Michigan

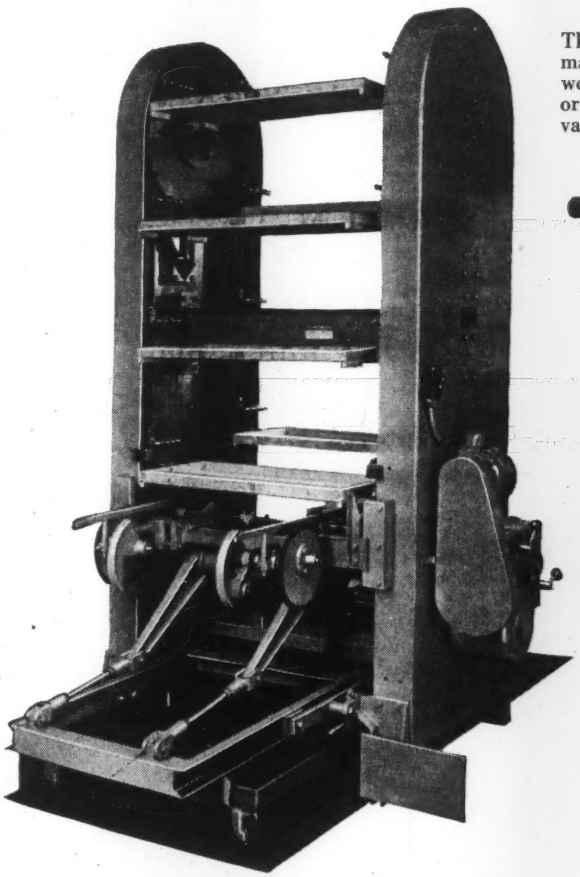
100 Morse Branch Offices and Distributors to supply your power transmission demands.

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under **"Power Transmission"** or **"Chains"** for the nearest Morse Man.



making CANDY...

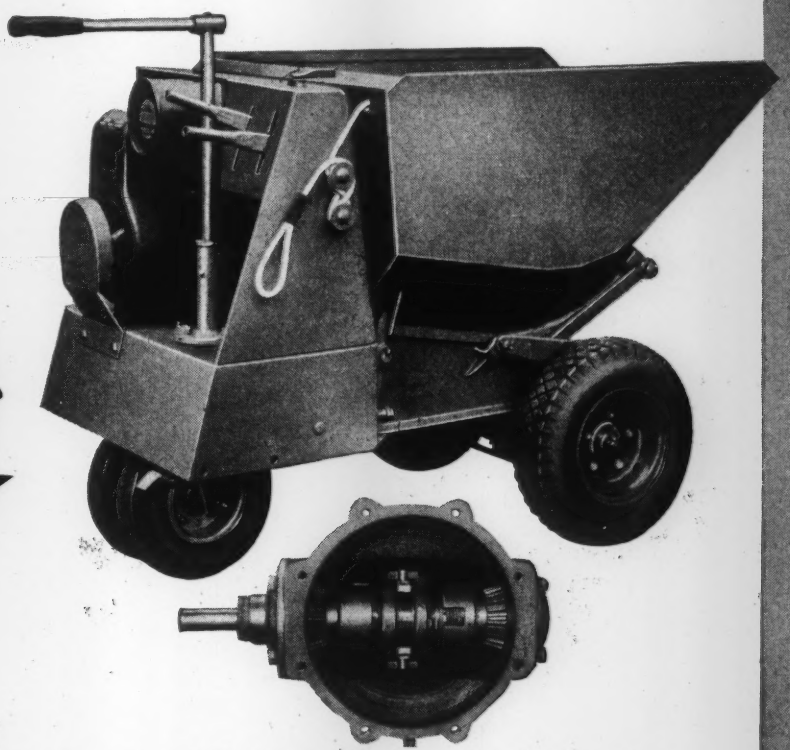
POWER TRANSMISSION PRODUCTS



Currie automatic starch tray stackers and feeders increase production, reduce tray breakage for candy manufacturers. Since their development about ten years ago, these machines have been equipped with Morse Roller Chain.

Morse Roller Chain provides positive power transmission without slippage, saves space, allows design freedom. Morse Roller Chain is precision-built for long, trouble-free service under a wide variety of working conditions. It uses teeth, not tension; gives 99% efficiency.

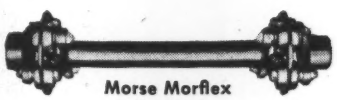
The Kwik-Mix Moto-Bug takes the hard work and high cost out of materials handling, the pulling and pushing out of wheelbarrow work. With a capacity of 1200 pounds or ten cubic feet in its hopper or on its interchangeable platform, the Moto-Bug handles a wide variety of materials.



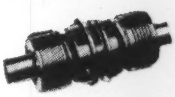
Double Morse-Rockford Pullmore Clutch on versatile Moto-Bug is used on main drive. It provides forward or reverse motion at full power. Particularly compact, powerful, smooth-running, the clutch has proved its efficiency, economy, and reliability in rugged service. Morse-Rockford Pullmore Clutches are made in single and double types, for dry operation or operation in oil in many capacities ranging from one to ninety horsepower at 500 r.p.m.

Morse Morflex Couplings

Morse-Rockford Clutches



Morse Morflex Drive Shafts



Morse-Rockford Pullmore Clutches

MORSE

MECHANICAL POWER TRANSMISSION PRODUCTS

PRODUCTS OF B-W BORG-WARNER

The Light

THAT MUST NOT FAIL

Automatic Airway Beacon Controlled by Telechron Timing Motor

Today's modern airfields leave nothing to chance. Airway beacons and airstrip lights flash on *automatically* at the first approach of dusk. Whether "dusk" occurs in mid-afternoon or at its duly appointed time, pilots need not fear for proper guidance while in flight. Lights respond to pre-determined light levels and function the instant they are needed.

Weston illumination controls permit this uniformly reliable regulation of lighting. Independent of human judgment or arbitrary light schedules, it is a great advance in aviation safety. These controls owe their dependability to Telechron Timing Motors — also used in aircraft instruction markers, street lighting and industrial lighting.

Instantly, constantly synchronous, Telechron Timing Motors give dependable performance every time.

Timing On Your Mind?

If you have a timing problem to contend with, a Telechron application engineer can be of great help to you. Backed by broad field experience, he can lead you to important savings in time and money. Consult him early in your planning. For immediate facts, send coupon below. TELECHRON INC. A General Electric Affiliate.

Telechron®

ALL TELECHRON TIMING MOTORS ARE INSTANTLY...CONSTANTLY SYNCHRONOUS

TELECHRON INC.
23 Union Street
Ashland, Massachusetts

Please send me information on sizes and types of Telechron Synchronous Motors. My possible application is:

Instruments	☐	Communications Equipment	☐
Timers	☐	Other (please fill in)	
Electric Appliances	☐	.....	
Cost Recorders	☐	.....	
Advertising, Display Items	☐	.....	
Juke Boxes	☐	.....	
Air Conditioning & Heating Controls	☐	.....	
		☐ Please send new Catalog	

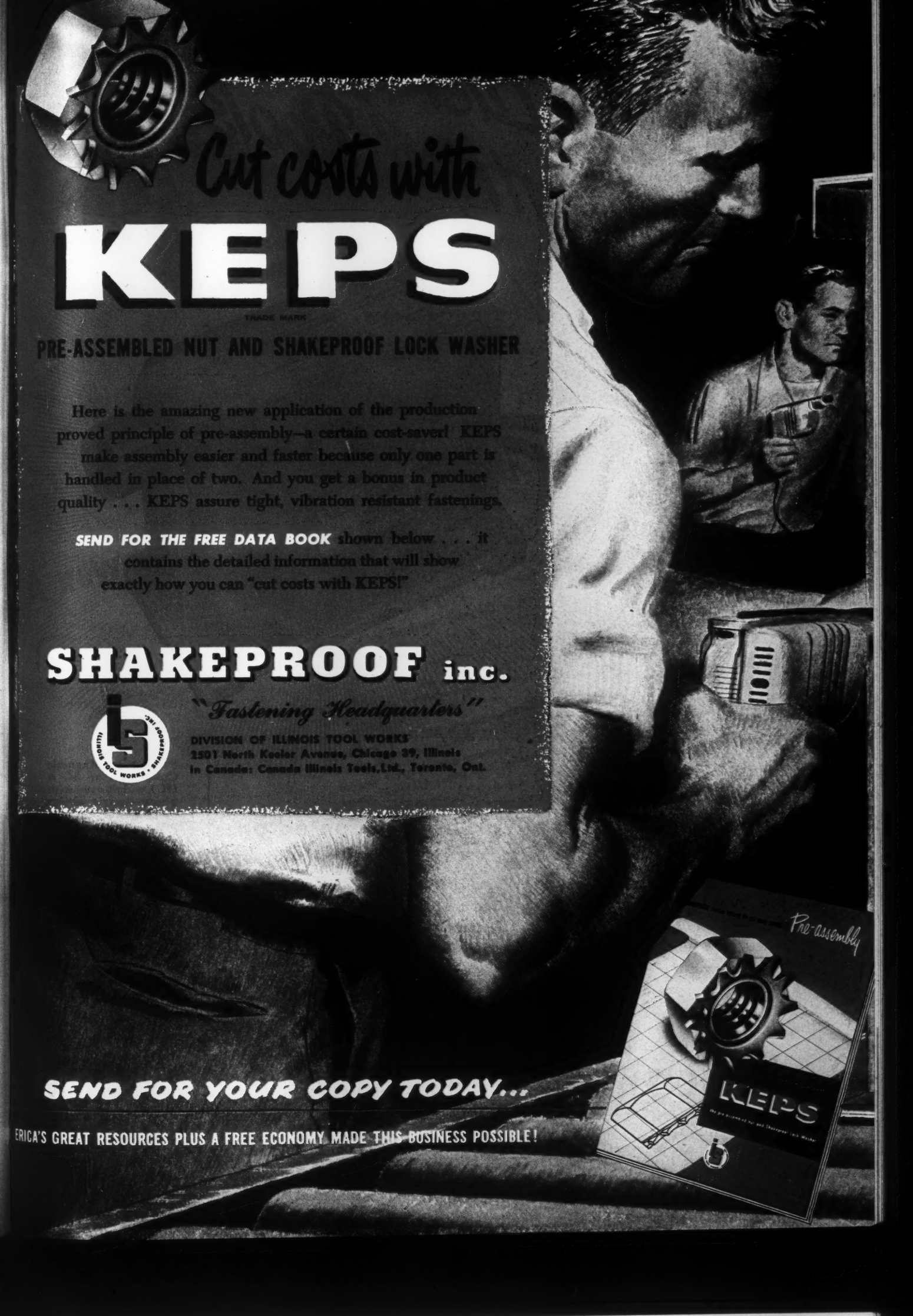
NAME.....

COMPANY .....

ADDRESS .....

CITY..... ZONE.....

STATE .....


Cut costs with
KEPS
TRADE MARK
PRE-ASSEMBLED NUT AND SHAKEPROOF LOCK WASHER
Here is the amazing new application of the production proved principle of pre-assembly—a certain cost-saver! KEPS make assembly easier and faster because only one part is handled in place of two. And you get a bonus in product quality . . . KEPS assure tight, vibration resistant fastenings.
SEND FOR THE FREE DATA BOOK shown below . . . it contains the detailed information that will show exactly how you can "cut costs with KEPS!"
SHAKEPROOF inc.
"Fastening Headquarters"
DIVISION OF ILLINOIS TOOL WORKS
2501 North Keeler Avenue, Chicago 39, Illinois
In Canada: Canada Illinois Tools, Ltd., Toronto, Ont.
ILLINOIS TOOL WORKS • SHAKEPROOF INC.
Pre-assembly
KEPS
SEND FOR YOUR COPY TODAY...
ERICA'S GREAT RESOURCES PLUS A FREE ECONOMY MADE THIS BUSINESS POSSIBLE!

Try Your Luck In Untried Pools!

. . . You may Land a Big One that you never counted on

You may get a strike that will amaze you . . . and your customers, too. You may net a whopper that will weigh up to be *the biggest sales advantage your product ever had* . . . the hidden ability to count to your customers' advantage. Like the milling machine builder who found he could build-in a Veeder-Root Counter to pre-set and control depth of cut.

And on such fishing expeditions, V-R engineers are expert (and remarkably successful) guides. When do you want to try *your* luck? Just write.

Series 1200 Magnetic Counters (for AC & DC), widely used with photo-electric relays or electric-eye equipment. These and scores of other electrical and mechanical counters are shown in FREE 8-page "COUNT BOOK" below. Send for your copy, *today.*

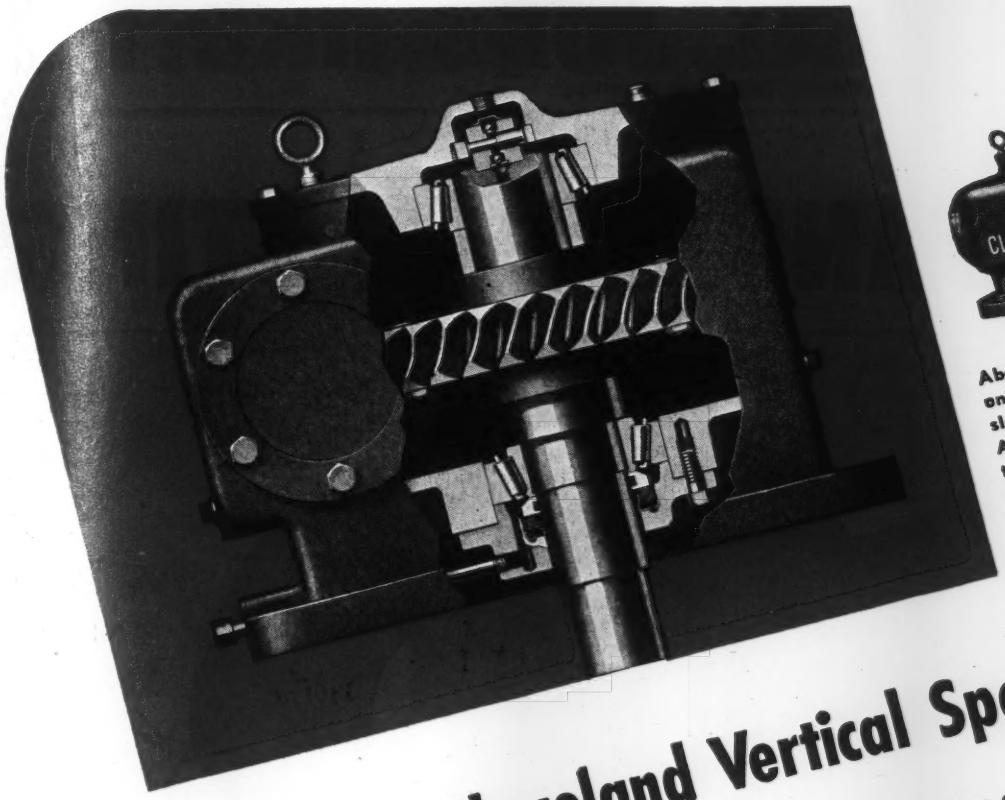
Veeder-Root **COUNTERS**

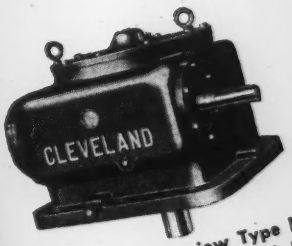
"Count Everything on Earth"

VEEDER-ROOT INC., HARTFORD 2, CONN.

Veeder-Root Inc., Hartford 2, Conn., (NEW Telephone Number: HArtford 7-7201)

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3
In Great Britain: Veeder-Root Ltd., Kilspindie Rd., Dundee, Scotland





Above—Exterior view Type ND unit. NU unit (not shown) has slow-speed shaft extending up. At left—Cutaway section to show tapered roller bearings on gear shaft, positive face-type oil seal, unique lubricating pump and oil drain at base of housing.

A new series of Cleveland Vertical Speed Reducers

● NU and ND worm gear units—in seven sizes each (50 to 500) are ready for prompt delivery. They are particularly suited to such equipment as agitators and mixers, and to overhead chain conveyors as well.

Outstanding features which insure that these new vertical drives will deliver long and trouble-free service are:

Extra heavy tapered roller bearings on gear shaft.

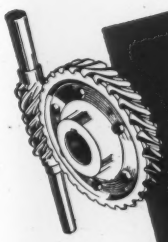
Continuous lubrication of top bearing by positively driven pump mounted on upper end of gear shaft (on lower end in Type NU).

Positive face-type oil seal below lower gear shaft bearing to prevent leakage.

Heavy base flange extends around all four sides. All parts liberally sized and precision built.

Write for Bulletin 125 for full description of Types NU and ND, including capacity charts and dimension data. The Cleveland Worm & Gear Co., 3265 East 80th Street, Cleveland 4, Ohio.

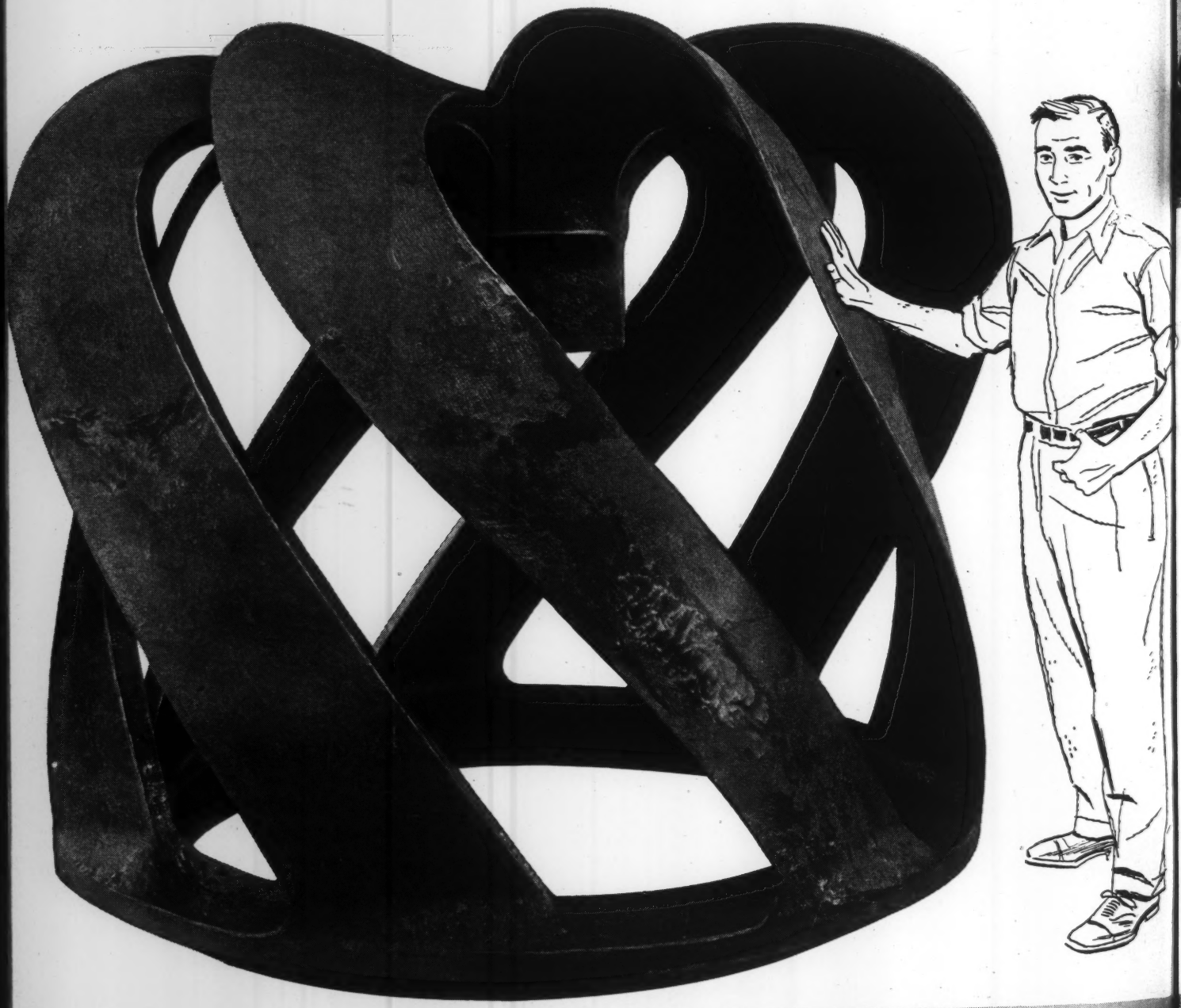
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.



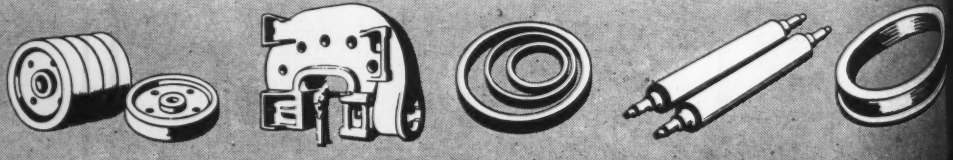
CLEVELAND
Worm Gear
Speed Reducers

UNUSUAL Jobs like this

of STANDARD CASTINGS

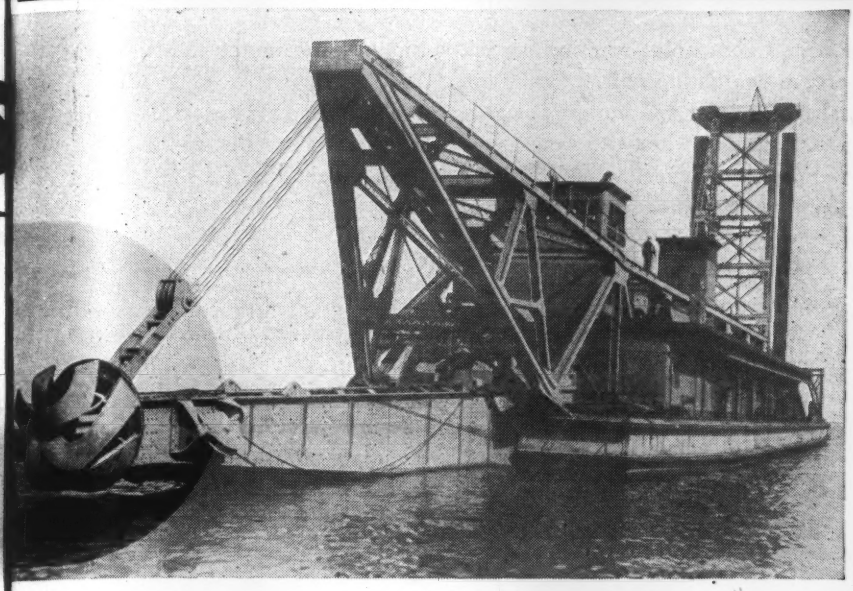


STANDARDIZE ON STANDARD FOR—



WHEEL MILL PRODUCTS, STEEL CASTINGS, WELDLESS RINGS, FORGINGS, FLANGES

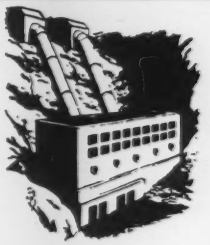
Certify the USUAL properties



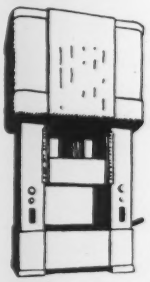
The giant cutter heads on Ellicott Hydraulic Dredges have a really tough job to do. They chew sand, silt, mud, clay, cemented gravel and disintegrated rock from the beds of rivers and lakes, loosening the material so it can be sucked up and discharged hydraulically.

Service of the heads calls for superior service qualities in the castings. Production of the heads calls for superior know-how in the pattern shop and on the casting floor. Ellicott found a single answer to these twin requirements—Standard Steel Works castings.

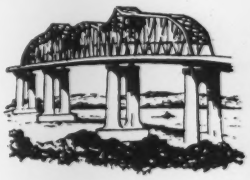
Big enough to have every needed facility—small enough to give every order careful, individual attention—Standard is a dependable source of supply for *unusual* castings which because of size, complication or special properties are beyond the abilities of the average foundry. If your casting requirements are in this category . . . just get in touch with Standard.



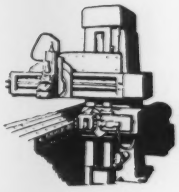
Standard has produced some of the largest turbine runners ever installed, for some of the nation's greatest hydro-electric developments.



Massive parts for mammoth presses, where loads run into hundreds of tons and the soundest, strongest castings are essential, are regularly produced at Standard.



Castings for bridge supports, and similar miscellaneous castings for structural or other uses, can be produced in any size and quantity in Standard's modern foundry.



Frames, bed plates and similar members for precision machine tools often demand special properties and unusual quality in the castings. Standard specializes on such production.

NOTICE

ATTENTION: DESIGN AND PURCHASING DEPARTMENTS

Standard is equipped to produce castings ranging in weight from 5 to 130,000 pounds for all classes of service. Recent developments in chemical compositions and heat treatments produce substantial improvement in physical properties. Whatever your needs—let Standard quote on your requirements.

BLW THE BALDWIN GROUP

BALDWIN

STANDARD STEEL WORKS DIVISION

THE BALDWIN LOCOMOTIVE WORKS: Standard Steel Works Division, Burnham, Pa., U. S. A.
Offices: Chicago, Cleveland, Houston, New York, Pittsburgh, San Francisco, St. Louis, Washington.

Here's the motor that "couldn't be built"!

It's the Holtzer-Cabot quiet-running capacitor motor — the motor that powers the Nesbitt schoolroom ventilating unit.

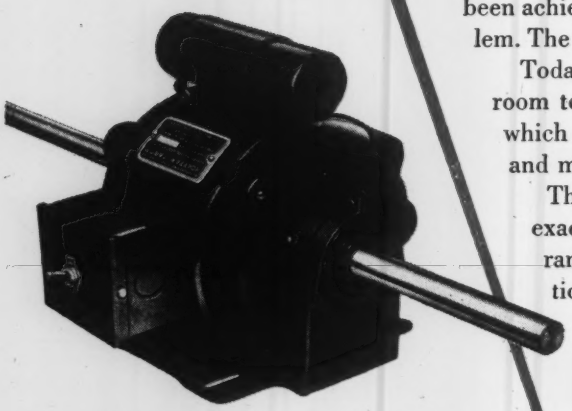
Previously, the hum of A.C. motors powering these units had proved so distracting as to be impractical. Hence, when alternating current only was available, motor-generator sets were required to convert to D.C.; but this arrangement was not too satisfactory because of the excessive additional cost.

Quite a problem!

The obvious solution was a really quiet A.C. motor — something that had never been achieved up to that time. Holtzer-Cabot engineers went to work on the problem. The result was an A.C. motor that performed perfectly . . . *and silently!*

Today, schools from coast to coast are using Nesbitt ventilator units in each room to furnish a continuing supply of fresh sweet air. These units, many of which are powered by Holtzer-Cabot motors, operate efficiently and quietly, and make possible full concentration in the classroom.

This is just another example of Holtzer-Cabot's ability to meet the most exacting specifications in small-motor applications. Holtzer-Cabot motors range from 1/2000 up through 1½ H.P., from 24,000 RPM to 1 revolution per day!



The Holtzer-Cabot RWC-6417, an improved version of the first silent A.C. motor developed to Nesbitt Co. specifications. Single phase, 1/12 H.P. single value capacitor type, with totally enclosed wool-packed sleeve bearing and a resilient base mounting. Shaft is 43" overall, ¾" in diameter, adjustable variable speed. Gives trouble-free performance.

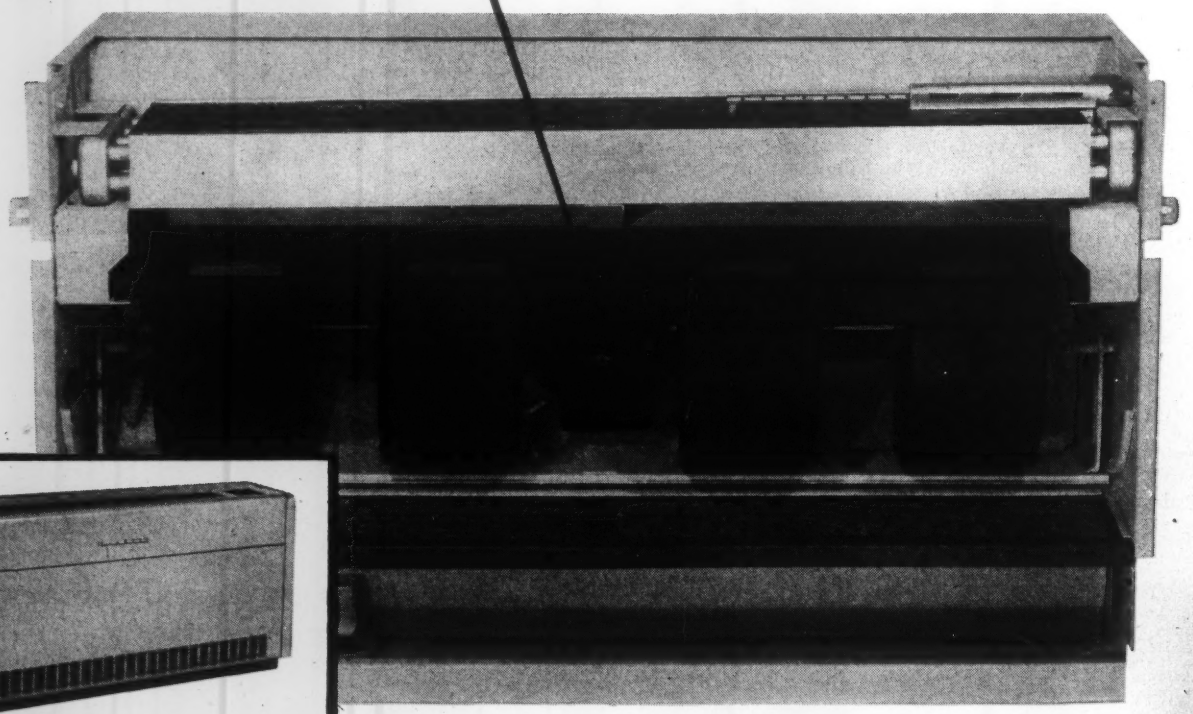
HOLTZER-CABOT

DIVISION OF NATIONAL PNEUMATIC CO., INC.

BOSTON 19, MASSACHUSETTS

"Manufacturers of fine electrical apparatus since 1875"

INVESTIGATE NOW... Holtzer-Cabot welcomes inquiries involving special motors



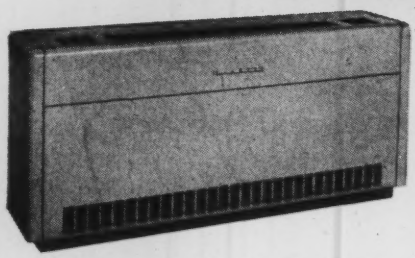


photo courtesy of John J. Nesbitt Co., Inc.

How to design joints for efficient sealing

Wherever you find chronic gasket failure or the forced use of high-cost gaskets, you often find a joint design that makes unreasonable demands on the gasket material.

There are occasions, of course, where inherent factors allow little leeway in joint design. In many cases, however, gasket abuse is caused by joints designed without taking into account the characteristics of the gasket material to be used. Under such circumstances there is always the risk that either sealing economy, sealing efficiency, or both may be sacrificed.

A typical example of this hazard is found in the joint illustrated above. As designed, this joint calls for a gasket that is both soft and hard. It has to be soft to conform to the irregular die-cast flanges; it has to be hard to resist torsion during assembly.

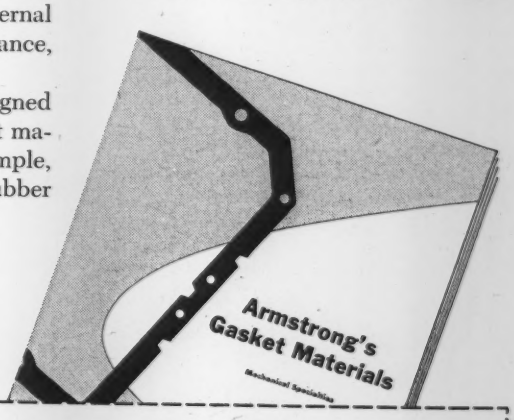
A solution was found by coating an Armstrong's Cork-and-Rubber Composition with a lubricant. It is probable, however, that this seal has a lower margin of safety than is desirable. A better solution would have been to catch this problem when the unit was on the drawing board. Then a joint that put the gasket under direct compression could have been provided, eliminating the need for gaskets with two opposed qualities.

There are a number of things that can be done in the design stage to insure better sealing results. When you know the nature of the solvent or other medium to be sealed, the probable internal pressure, and the approximate bolting pressure involved, you can make a tentative choice of a suitable gasket material. Here your Armstrong representative will be glad to offer suggestions based on his experience with many different sealing problems.

Next, the joint itself should be considered with respect to the needs of the unit of which it is a part. For example, precise alignment of internal parts may dictate a close-tolerance, metal-to-metal flange.

This joint then should be designed on the basis of the type of gasket material initially chosen. If, for example, one of Armstrong's Cork-and-Rubber Compositions has been chosen, the design can be very simple, a channel of the depth and width required by the pressures involved and the hardness or softness of the chosen material. On the other hand, if straight rubber is your choice, either a precision-molded gasket or a relief for side flow may be required, both adding to costs.

All the factors involved in joint and gasket design obviously cannot be covered here. For a more complete discussion of the relation of gasket width to load, the effect of surface condition and of oil on gaskets, practical gasket tolerances, etc., refer to Armstrong's Gasket Materials Manual in Sweet's file for product designers. If you would like a personal copy of the manual, fill in and mail the coupon below.



New Gasket Handbook Now Available

You'll find useful application and specification data in "Armstrong's Gasket Materials." This booklet contains up-to-date information on the various Armstrong's Sealing Materials, plus technical discussions covering many important factors that influence modern joint and gasket design. See Sweet's file for product designers or send coupon for your personal copy.

ARMSTRONG'S
GASKETS • PACKINGS • SEALS

ARMSTRONG CORK COMPANY
Gaskets and Packings Dept.
5112 Arch St., Lancaster, Pa.

Please send me at once a free copy of the new 20-page booklet, "Armstrong's Gasket Materials."

NAME.....
COMPANY.....
ADDRESS.....
CITY.....STATE.....

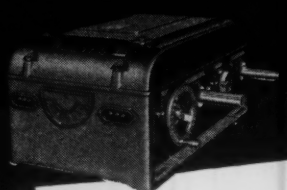
For keeping the machines you build in perfect step . . .

. . . and in full production at all times . . .

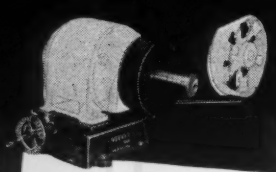
Reeves Speed Control

accurate!
positive!

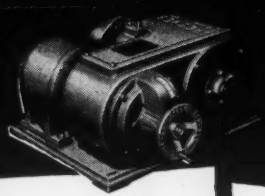
Choose from the complete line—REEVES!



Variable Speed Transmission for providing infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes available: fractional to 87 hp.



Vari-Speed Motor Pulley provides an instantly variable speed drive within 4:1 ratio for any constant speed motor. In sizes to 10 hp.



Motodrive combines motor, speed varying mechanism and reduction gears in a single unit. Speed variations 2:1 to 6:1, inclusive. Sizes to 20 hp. (Also available in fractional hp sizes with speed variations to 10:1.)

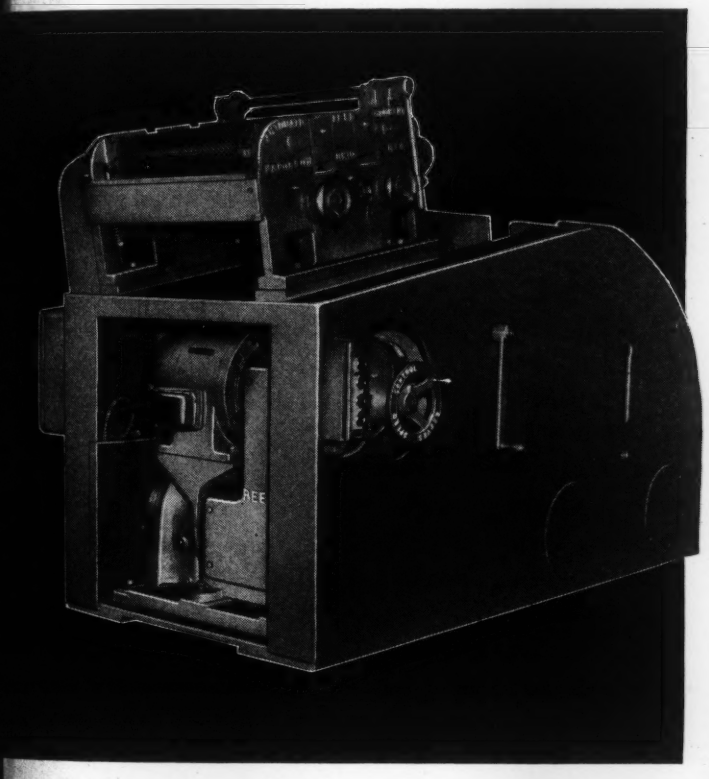
Vari-Speed Jr., a compact, low-cost unit for light machinery. Takes any standard V-belt. Ratios, 1¾:1 to 2¾:1. Sizes—⅛ through 1½ hp.

Who wins the ball games? The team that works together. And who wins the production battles? The manufacturer with the machines and the men that *mesh together* like cogs in a clock.

Synchronization is the word. And that's where accurate, positive REEVES Variable Speed Control fits into your picture as a designer or builder of the new, improved machines your customers are demanding. For *synchronization* is one of the basic and essential functions REEVES does best . . . *precise synchronization* of working parts of one machine or machines operating in series so that production proceeds at the fastest and most profitable pace possible at all times and under all operating conditions.

For *synchronization* or any of the other functions listed below, rely on REEVES—the pioneer and leader—to solve your speed control problem. The REEVES line, now standard equipment on more than 2,100 different makes of machines, is the most complete in the industry—including designs, sizes, capacities, speed ratios and controls to meet the needs of any machine on your production line or on your drawing board.

A REEVES engineer who knows speed control "inside out" will be glad to help you solve your own particular speed control problem, without any obligation on your part. Write for his name and the *free* catalog described below.



Keep from behind the eight-ball—specify Reeves for any of these eight basic functions

1. Handle more sizes, shapes and materials.
2. Match variations in number or skill of operators.
3. Compensate for changes in consistency, density or viscosity of materials in process.
4. Maintain uniform pressure, weight, liquid level, temperature and other variable elements.
5. Maintain uniform peripheral speed (or tension) on decreasing or increasing diameters.
6. Accurately control heating, baking, drying, cooking, cooling or chilling time.
7. Regulate conveyor speeds—even to fractions of an inch per minute.
8. Synchronize all working parts—of one machine or machines operating in series.

Example: REEVES Vari-Speed Motodrive is standard equipment on this Automatic Feed, Cradle and Straightener manufactured by Automatic Feed Company, Napoleon, Ohio. This machine is designed for use on automatic punch presses and, by means of the REEVES unit, its operation is closely synchronized with that of the press. Feed speed is quickly varied to handle different types and thicknesses of material, thus assuring maximum rate of production, minimum number of rejects and uniform quality at all times.

Free!

Write for your copy of comprehensive, 132-page book covering entire REEVES line in detail. Ask for REEVES Catalog H-55-3N.

accurate · variable
REEVES *Speed Control*

REEVES PULLEY COMPANY · COLUMBUS, INDIANA

Recognized Leader in the Specialized Field of Speed Control Engineering

Here's what Safety-Circle means to your customers

✓ All-Around Protection

✓ Low Maintenance

✓ Dependable Performance

The SAFETY-CIRCLE

The Allis-Chalmers *Safety-Circle* is the frame and ends of heavy cast iron that completely surround and protect the working parts of the *Safety-Circle* motor.

ALLIS-CHALMERS "Safety-Circle" DESIGNERS' MOTORS

SAFETY-CIRCLE MOTORS are protected all around against those great motor killers—corrosion . . . distortion and friction.

Frames are of cast iron, which *inherently* resists corrosion. The natural strength of cast iron is supplemented by heavy ribbing and bracing . . . has high safety factor to maintain alignment and prevent distortion. Pre-lubricated bearings are packed and sealed at the factory . . . require no attention for years. And, end brackets are drip-proof at no extra cost.

Safety-Circle Motors are fully protected inside, too. Multiple dipped and multiple baked stator windings plus inter-phase insulation provide extra protection against electrical breakdowns.

CERTIFIED SERVICE

Another reason for supplying *Safety-Circle* motors on your equipment. There are 86 service shops to give your customers quick, factory approved parts and service in every major industrial area. Check coupon at right for details. And, when you do specify *Safety-Circle* motors, be sure to order matching Allis-Chalmers controls.

ALLIS-CHALMERS, 1001A SO. 70 ST.
MILWAUKEE, WIS.

Please send me:
Handy Guide for Electric Motors Bulletin 51B6052
Flange Motor Specifications Sheet 5157234
Safety-Circle Motors Bulletin 51B6210B

Name _____

Title _____

Company _____

Street _____

City _____ State _____

A-3166

Safety-Circle is an Allis-Chalmers trademark.

ALLIS-CHALMERS

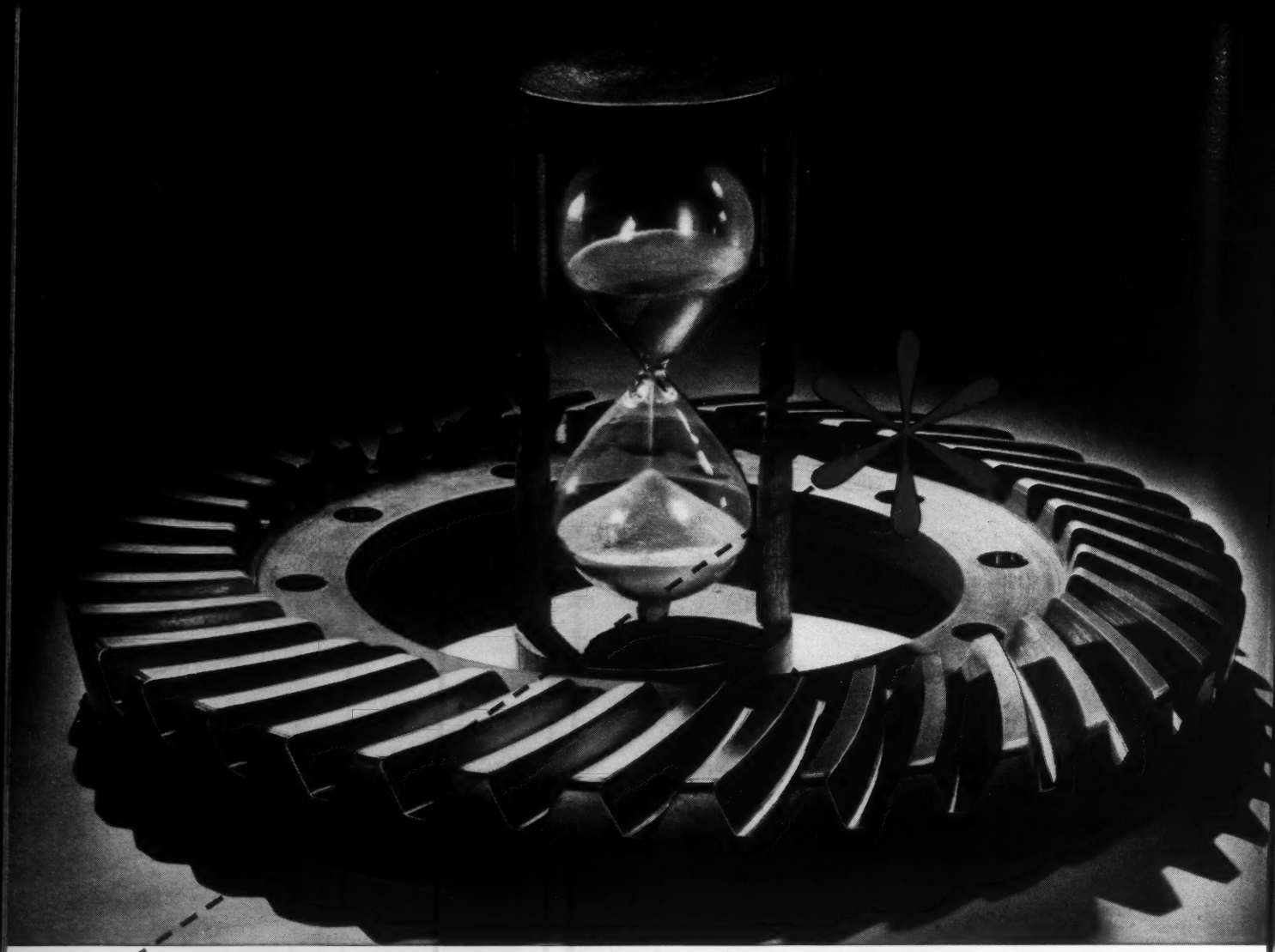
A-C ALLIS CHALMERS

SOLD AND APPLIED BY AUTHORIZED DEALERS, AND DISTRICT OFFICES THROUGHOUT U. S., SERVICED BY CERTIFIED A-C SERVICE SHOPS

The world's fullest market basket naturally takes the shape of America. For that fact thank *industry* — steel mills and textile mills, paper mills and oil wells, machine tool plants and tractor plants, every place where wheels turn and men work. Wheels turn faster and men work more efficiently in *every* industry because of anti-friction bearings. And every industry knows and uses SKF Ball and Roller Bearings. Every industry knows SKF as pioneers. Every industry knows that SKF engineering anticipates their needs for exactly the right bearing to do the job at hand. **SKF** INDUSTRIES, INC., PHILADELPHIA 32, PA., *the Pioneers of the Deep-Groove Ball Bearing, Spherical Roller Bearing, Self-Aligning Ball Bearing.*

7031

HELPING MAP OUT *America's* 276-BILLION DOLLAR MARKET BASKET



* Does "YEARS" rhyme with "GEARS" for you?

THE HAPPY COINCIDENCE of these rhyming words tempts us to write an advertisement in poetry. But cold business sense sounds better in prose.

The gears you buy should be built to last for years. If they don't—if they require frequent service or replacement—they have a tremendously high final cost, no matter what figures were on the purchase order.

"Double Diamond" gears are built to last for *years*—to produce low installed cost—to serve economically and dependably on the job for which you buy them—and to do credit to your product and your reputation.

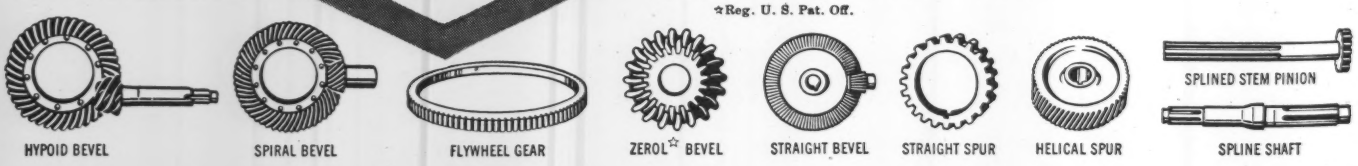
Speaking further of years—"Double Diamonds" have been made to these standards since 1914. We would be pleased to enter our 37th year making gears for you. Why not write for more entirely non-poetic information?

DOUBLE DIAMOND
TRADE MARK
GEARS

Automotive Gear Works, Inc.
RICHMOND, INDIANA

• • • • FOR AUTOMOTIVE FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS • • •

☆Reg. U. S. Pat. Off.



Further Information?

IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

Here's What You Do:

Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want—whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

Please send further information on the following advertisements in this issue:

PAGE NO.	NAME OF ADVERTISER	Send Technical Data	Send Price Information	Nearest Source of Supply
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MD12-50

FIRST CLASS
PERMIT No. 36
(Sec. 34.9 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

Please send further information on the following advertisements in this issue:

PAGE NO.	NAME OF ADVERTISER	Send Technical Data	Send Price Information	Nearest Source of Supply
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MD12-50

Further Information?

IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

Here's What You Do:

Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want—whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

FIRST CLASS
PERMIT No. 36
(Sec. 34.9 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

Please send further information on the following advertisements in this issue:

PAGE NO.	NAME OF ADVERTISER	Send Technical Data	Send Price Information	Nearest Source of Supply
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○
-------	----------	○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MD12-50

FIRST CLASS
PERMIT No. 36
(Sec. 34.9 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

EVER TRY STARTING WITH THE FINISH?

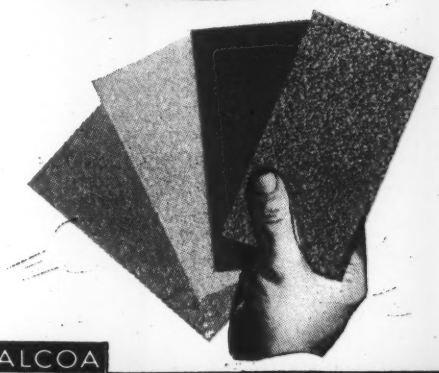
ONE of the interesting things about aluminum is that it can take every type of finish—from simple sand blasting to vitreous enamel, from conventional paints and lacquers to unique anodic coatings possible only with aluminum. And some of these finishes allow spectacular design flexibility. For example . . .

You might be designing a hydraulic system for aircraft. You want light weight cylinders and pistons. But you have greater need for wear resistance. With an anodic coating, you can give these aluminum pistons and cylinders a file-hard surface comparable to hard-chrome plating.

You may be concerned with the cost of a particular finish. Many finishes can be applied right at Alcoa's mills . . . saving you heavy investments in special equipment and manpower. These include Alzak* reflecting surfaces, Alumilite* finishes for gay, built-in color; special anodic coatings for greater corrosion resistance, or high dielectric strength; as well as a variety of decorative mechanical finishes.

An important thing to remember is that such finishes can be obtained on semi-fabricated parts made in Alcoa plants, to Alcoa quality standards, and available to you through a single, dependable source.

*Patented Process



Starting with the finish might prove an important way for you to reduce costs and improve quality. Any Alcoa sales office will be glad to consult with you about it.

ALCOA

ALCOA

FIRST IN ALUMINUM

In the following pages, Alcoa presents facts for sales designers on representative Alcoa products. On the last page of the Alcoa section will be found the Alcoa offices through which information on aluminum is available. ALUMINUM COMPANY OF AMERICA, Gulf Building, Pittsburgh 19, Pennsylvania.

THE ALCOA PRODUCTS ADVERTISED ON THESE PAGES ARE BACKED BY ALCOA'S RIGID QUALITY CONTROL...

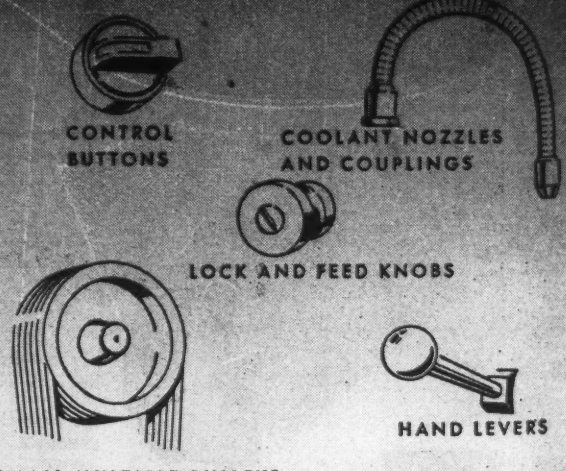
MEMO TO MACHINE TOOL MANUFACTURERS

ALCOA ALUMINUM SAVES ON SCREW MACHINE PARTS

Take a screw machine part you now make and figure what you can save by switching to Alcoa Aluminum Stock. You get three times as many parts per pound from aluminum.

Machining costs are the same as brass... lower than steel. Aluminum requires no finish. But if you want a finish, aluminum takes and holds them all.

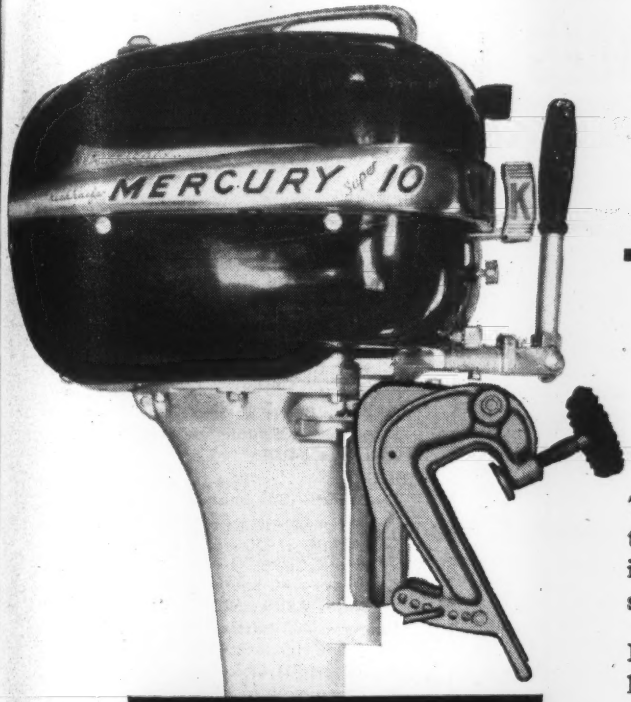
Once you see the savings on one part, you'll want to see more. All the information you need is contained in the free book, "Alcoa Aluminum in Automatic Screw Machines". Write ALUMINUM COMPANY OF AMERICA, 2116M Gulf Building, Pittsburgh 19, Pa.

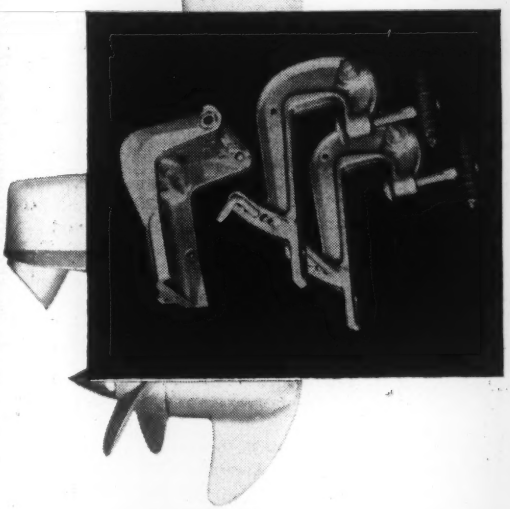


ALCOA Aluminum SCREW MACHINE STOCK

ALCOA ALUMINUM

IN ADAPTING THEM TO YOUR USE, YOU ARE INVITED TO MAKE FULL USE OF ALCOA'S OUTSTANDING ENGINEERING HELP





ALUMINUM CLAMP AND SWIVEL BRACKET ASSEMBLY introduced on Mercury Outboard Motors in 1950, with phenomenal results . . . not one instance of breakage reported during entire boating season. Designed by Kiekhaefer Aeromarine Motors, Inc. Forged by Alcoa.

. . . for Aluminum Forgings SEE ALCOA

Today's outboard motors are lighter, tougher, more powerful than ever before. Progress in outboarding, as in many other industries, has been achieved through the use of lighter, stronger materials . . . especially at the stress points.

If you are considering aluminum forgings as a way to design light weight and high strength into essential products, talk it over with our engineers. At Alcoa, forging experience teams up with improved facilities and new production techniques to give you quick, economical access to these valuable advantages . . .

- Light weight, combined with forged strength and compactness
- Tough, finely-knit grain structure
- Excellent, uniform physical properties
- Superior machinability
- Attractive appearance
- High resistance to corrosion
- Rapid heat transfer

Write for complete engineering information on Alcoa Forgings for your special application. Or just mail the coupon below. Our forging specialists are ready to work with you. If you would like to receive a copy of the new Alcoa Forgings Manual, please send request on your company letterhead.

Aluminum Forgings by **ALCOA**

MAIL COUPON FOR FREE ENGINEERING HELP

ALUMINUM COMPANY OF AMERICA
1807M Gulf Building
Pittsburgh 19, Penna.

Please send me full information on aluminum forgings for the following application:

_____

_____

Name_____ Position_____

Company_____

Address_____

City_____ State_____

THESE ALCOA SALES OFFICES *Will Aid You*

These sources of the Alcoa products (described on the preceding pages) are as near as your telephone. Let them serve you with engineering help, literature, and a pound or a ton of the Alcoa product that best meets your needs.

ALABAMA
Birmingham—505 First National Bldg.
Phone 4-8593

CALIFORNIA
Los Angeles—108 West 6th Street
Phone Tucker 5121
San Francisco—615 Russ Bldg.
Phone Yukon 6-6484

COLORADO
Denver—524 U. S. National Bank Bldg.
Phone Tabor 4638

CONNECTICUT
Fairfield—1333 Post Road
Phone Fairfield 9-5221
Hartford—Capital Bldg., 410 Asylum St.
Phone Hartford 5-2192 to 5-2196

DELAWARE
Wilmington—Delaware Trust Bldg.
Phone Wilmington 8-4138 and 8-4139

FLORIDA
Tampa—1004 Tampa Theatre Bldg.
Phone 2-1984
Miami—1129 Alfred I. Du Pont Bldg.
Phone Miami 9-0651

GEORGIA
Atlanta—1800 Rhodes-Haverty Bldg.
Phone Cypress 4681-2-3-4-5

ILLINOIS
Chicago—520 N. Michigan Ave.
Phone Delaware 7-8181
Peoria—415 Commercial Natl. Bank Bldg.
Phone 3-4224 and 3-1784

INDIANA
Fort Wayne—1935 Lincoln Tower
Phone Eastbrook 4676
Indianapolis—817 Merchants Bank Bldg.
Phone Market 2501
South Bend—805 J. M. S. Bldg.
Phone 2-3333

IOWA
Davenport—503 Kahl Bldg.
Phone 2-6243 and 2-6244

KANSAS
Wichita—411 Fourth Natl. Bank Bldg.
Phone 5-6624

KENTUCKY
Louisville—1154 Starks Bldg.
Phone Wabash 7456 and 7457

LOUISIANA
New Orleans—627 Whitney Bank Bldg.
Phone Canal 3372

MARYLAND
Baltimore—400 Baltimore Life Bldg.
Phone Saratoga 8091 to 8094

MASSACHUSETTS
Boston—20 Providence St., Park Square
Phone Hancock 6-2638, 6-2639,
6-2640, 6-2641, and 6-2694
Springfield—507 Tarbell—Watters Bldg.
Phone Springfield 3-5103

MICHIGAN
Detroit—610 New Center Bldg.
Phone Trinity 1-8100
Grand Rapids—812 Michigan Natl. Bank
Bldg., Phone Grand Rapids 9-0209
Jackson—1203 National Bank Bldg.
Phone Jackson 2-8206
Pontiac—301 Pontiac State Bank Bldg.
Phone Pontiac 4-1531

MINNESOTA
Minneapolis—1060 Northwestern Bank
Bldg., Phone Atlantic 3528

MISSOURI
Kansas City—2300 Power & Light Bldg.
Phone Victor 3870
St. Louis—10th Floor, Continental Bldg.
Phone Franklin 6700

NEW JERSEY
Newark—744 Broad Street
Phone Market 2-6664

NEW YORK
Albany—90 State Street
Phone 4-0146, 4-0147, 6-7489
Buffalo—1880 Elmwood Avenue
Phone Riverside 2880 to 2884
New York—230 Park Avenue
Phone Murray Hill 6-8046 to 6-8058
Rochester—1331 Lincoln Alliance Bank
Bldg., Phone Baker 2630
Syracuse—408 State Tower Bldg.
Phone 3-0156

OHIO
Cincinnati—801 Enquirer Bldg.
Phone Parkway 7700
Cleveland—1450 Terminal Tower
Phone Cherry 1-6880
Columbus—40 South Third Street Bldg.
Phone Adams 5251
Dayton—302 Harries Bldg.
Phone Hemlock 1112
Toledo—1801 Ohio Bldg.
Phone Main 6295

OREGON
Portland—510 The U. S. Natl. Bank Bldg.
Phone Atwater 6605

NORTH CAROLINA
Charlotte—616 Johnston Bldg.
Phone 4-9751

PENNSYLVANIA
Allentown—913 Hamilton Street
Phone Allentown 3-7463 and 3-7464
Philadelphia—123 S. Broad Street
Phone Kingsley 5-0250 to 5-0257
Pittsburgh—2012 Oliver Bldg.
Phone Atlantic 1-4545
York—205 Manufacturers Bldg.
Phone York 2044 and 7441

RHODE ISLAND
Providence—815 Industrial Trust Bldg.
Phone Jackson 1-4108 and 1-4109

TEXAS
Dallas—301 Thomas Bldg.
Phone Riverside 6292
Houston—1806 Commerce Bldg.
Phone Preston 7106

VIRGINIA
Richmond—213 Exchange Bldg.
Phone Richmond 3-8393 and 3-8394

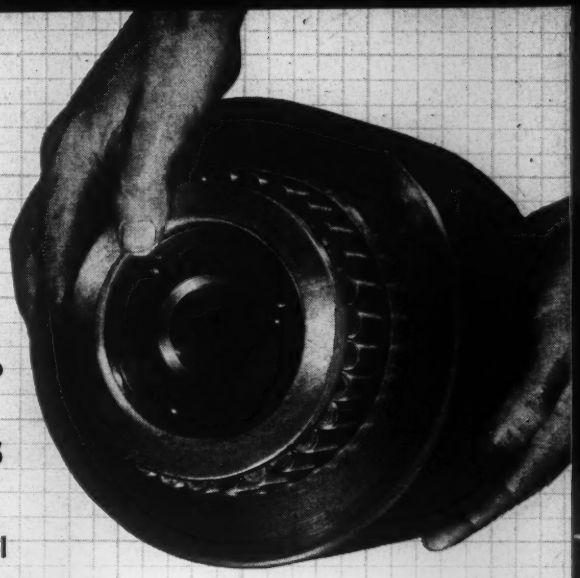
WASHINGTON
Seattle—1411 Fourth Ave. Bldg.
Phone Main 1868

WISCONSIN
Milwaukee—735 N. Water Street
Phone Marquette 8-0185

DISTRICT OF COLUMBIA
Washington—1200 Ring Bldg.
Phone District 9400

ALCOA ALUMINUM

ALCOA ALUMINUM ®



when the pressure is on . . .

USE TORRINGTON BEARINGS

It takes tremendous pressure to reduce cold strip steel 30 to 50% in one pass on thicknesses of .010" and less to close tolerances.

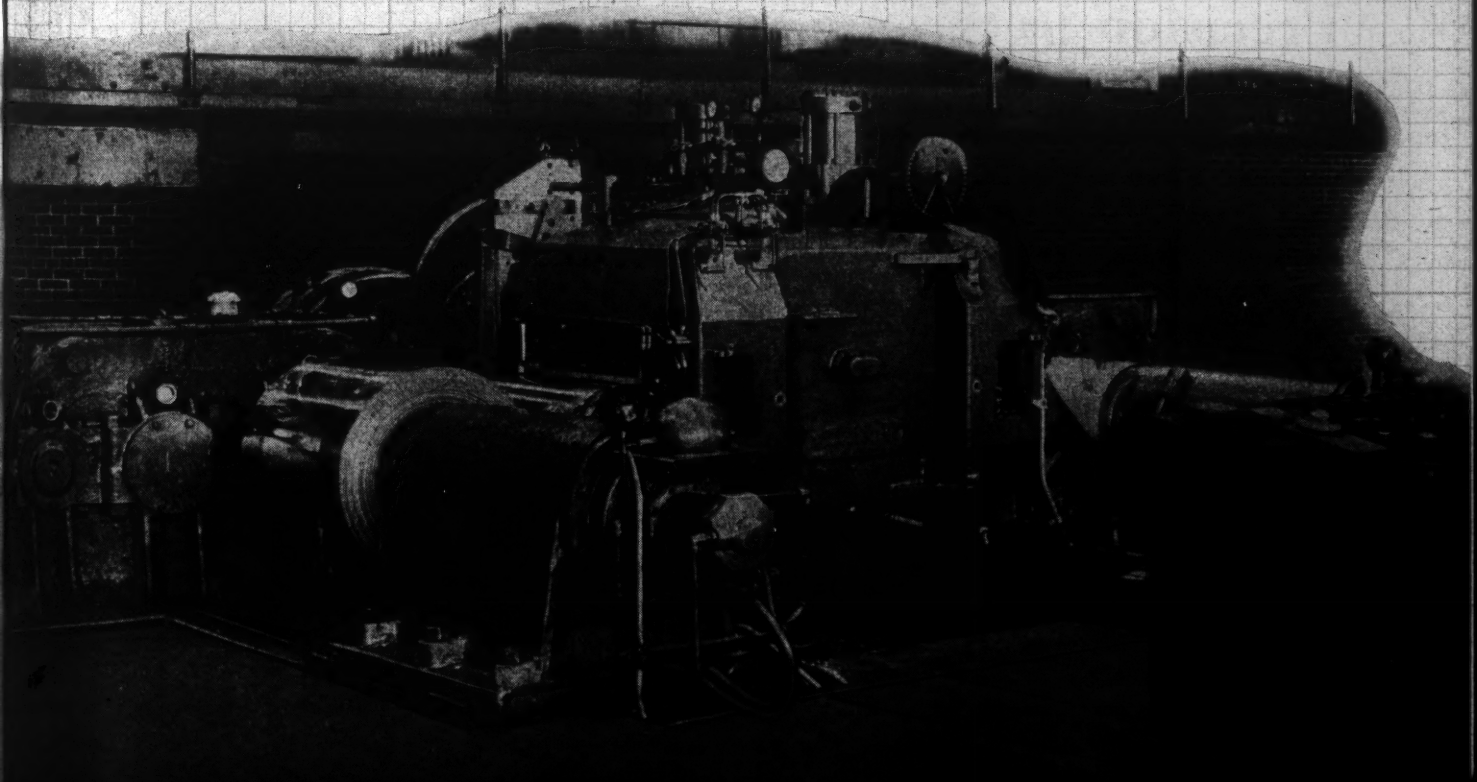
Sendzimir cold strip mills, engineered by Armzen Company, do it by using small diameter work rolls, rigidly backed by precision Torrington Bearings through the intermediate rolls. These bearings carry the tremendous loads and allow the mill to start and stop without resetting the gage.

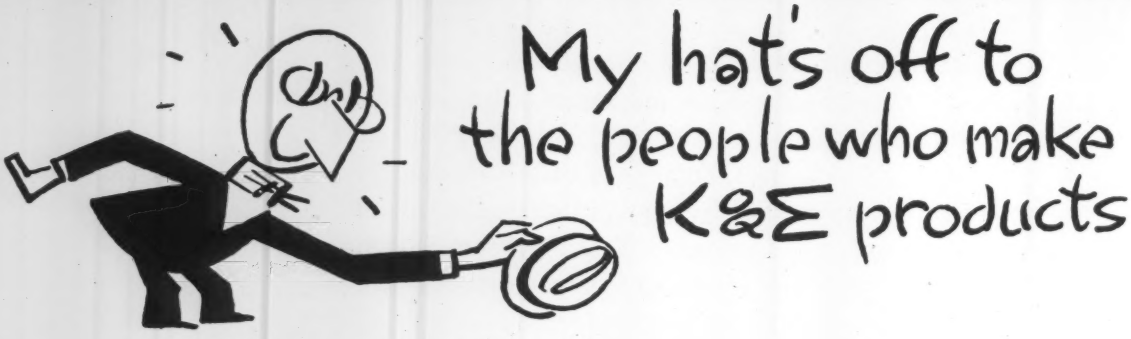
Your equipment, too, will duplicate such results under heavy working loads if Torrington Bearings are used. Torrington engineers will gladly help you adapt them to your specific requirements.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER
TAPERED ROLLER
STRAIGHT ROLLER
NEEDLE
BALL
NEEDLE ROLLERS

TORRINGTON BEARINGS





Take a bow, fellers!

Precision and quality don't grow on trees. But they grow.

At Keuffel & Esser precision and quality are almost a century plant. In other words they have been growing there in fertile soil for exactly 83 years. (K&E was founded in 1867.)

It's mostly a matter of people. Oh, there are machines, too, big ones, little ones—some of them almost human—but it takes people to imagine the machines, and to master them and supplement them.

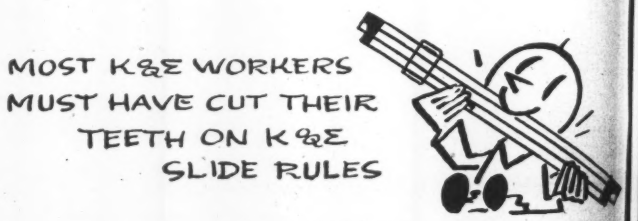
Precision in the Air

I've been talking about K&E products for a long, long time. Maybe it's time I talked a little about the people behind them.

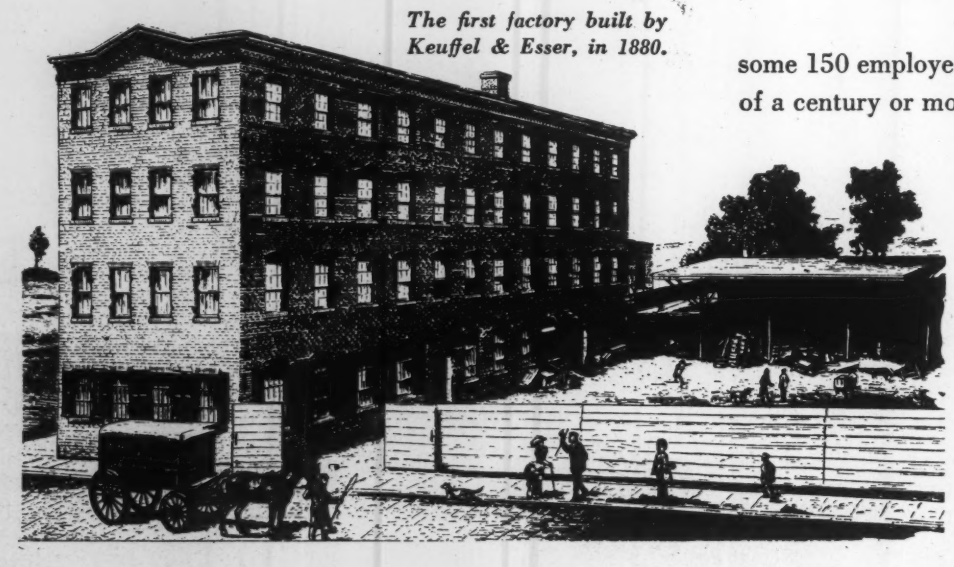
I've just been through the K&E factory at Hoboken again. I wish you could have been along, because you, as an engineer, would have seen much more than I. But even I could sense the honest craftsmanship and the father-and-son tradition of precision and the zeal for quality in the air.

You just don't get to be that fine in one generation.

There are a number of K&E employees who have been around for about a half a century, and there are some 150 employees who have been there for a quarter of a century or more. This latter bunch of kids, as well as the young sprouts who have been there only 20 or 15 years, have inherited the K&E feeling for doing things the good, old, exciting, honest way.



The first factory built by Keuffel & Esser, in 1880.



But don't get the idea that there is any moss on K&E. An outfit that has thrived this long has to have the knack of remaining perennially young and of keeping ahead of the pack.

"Partners in Creating"

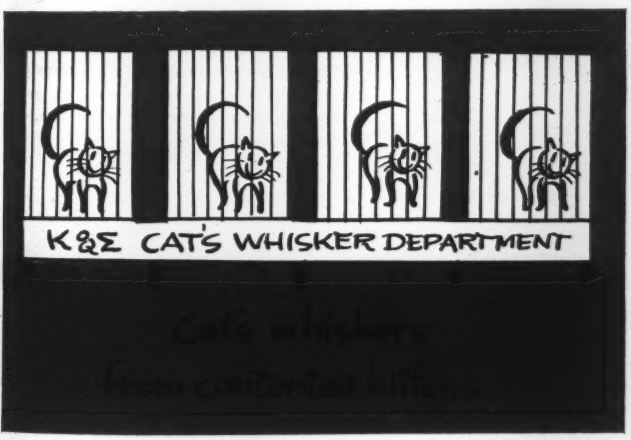
When K&E coined the phrase "Partners in Creating," they of course meant not themselves but their products. And it's true that K&E products have been in with engineers, scientists, draftsmen and architects on the

The K&E trade mark for decades, and the more modern one adopted in recent years.

creation of most of the big man-built wonders of the world for over 4/5 of a century.

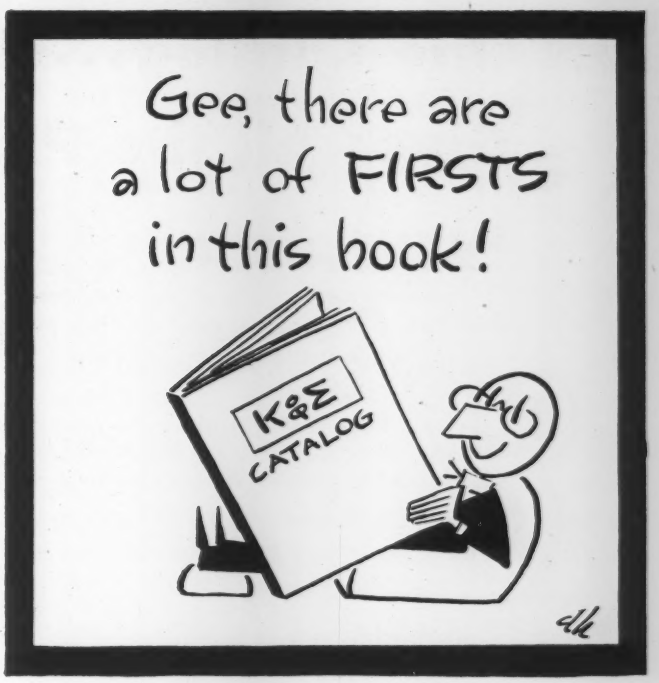
Zippy at 83

K&E have remained alert and alive, as is evidenced by their unending originality and inventiveness. They made America's first slide rules, as far back as 1891. And in both world wars, they did a big development job on optical equipment for our fighting men—on vital things such as periscopes, fire control instruments and height finders. The K&E catalog is full of "firsts"—some of them plenty recent, such as Wyteface* Measuring Tapes and Leroy† Lettering Equipment. No wonder it's the engineers' encyclopedia.



Factories within a Factory

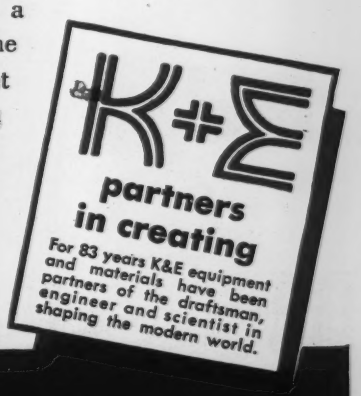
K&E headquarters are a town within a town, many factories within a factory. In one area they're coating miles of papers and cloths. In another they're turning screws so tiny you feel like a hippopotamus if you try to pick one up. Here they're grinding optical lenses.



There they're putting graduations no bigger than a fly's kneecap on scales of some sort. Here they're doing fastidiously fine leather work. There they're reeling off steel measuring tapes by the mile.

K&E was in there, sighting, in World Wars I and II

But wherever you go you are aware of the age-old passion for precision and quality. And I'm not the least bit sorry that today I haven't sold you a single K&E product. I've just tried a little bit to sell you on the people at K&E—and to get you to believe that you can safely make K&E products trusted partners in your own creative work.



*Trade Mark
†Trade Mark ®

Just One Catalog...CRANE Gives All the Piping Specs

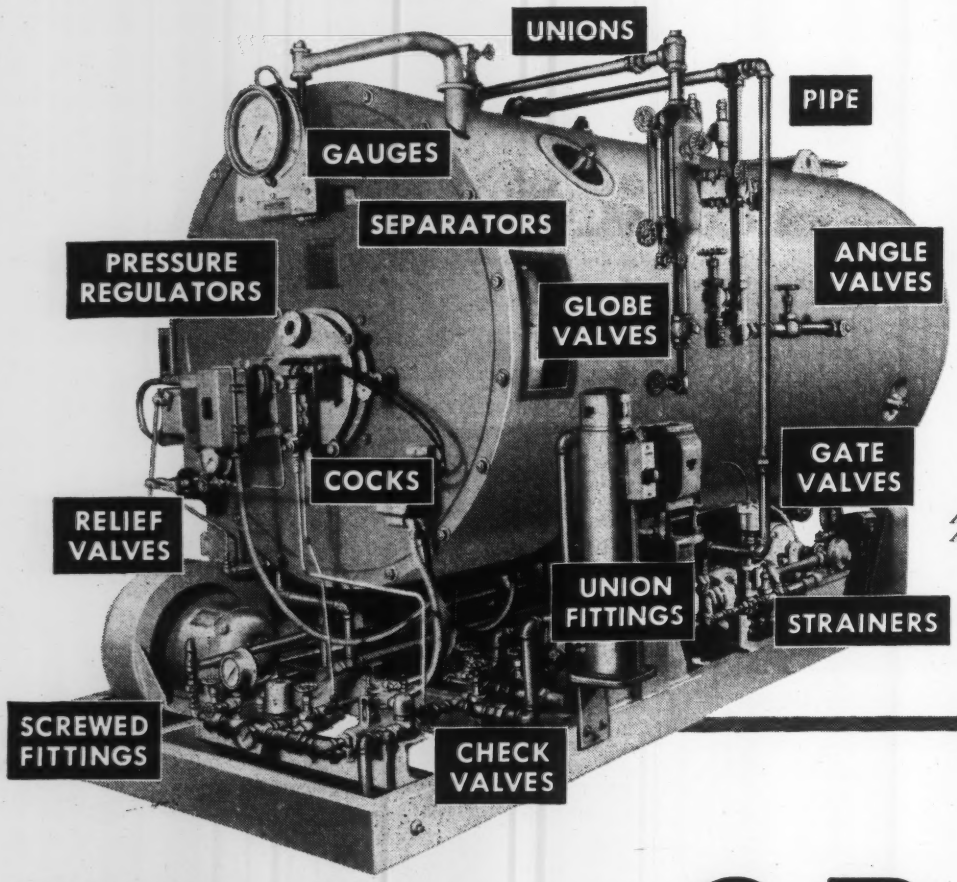
To take a case in point: suppose you're designing the *Steam Generator,* shown here. What's the quickest way to find all the valves, fittings, pipe and accessories you need? Turn to your Crane Catalog. It contains the world's most complete selection of quality piping equipment . . . helps cut specifying time to the minimum.

To rely on Crane simplifies all piping procedures. Ordering and storekeeping, for example, are greatly simplified when you can get everything in piping from a single source. Shop assembly goes smoother, too.

Most important to you, of course, is the added value your product acquires when all flow control equipment is Crane. Your customers know from experience that Crane Quality stands for the best in piping materials.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

FOR BETTER SELECTION EVERY TIME
. . . LOOK TO THE COMPLETE CRANE LINE



FOR THROTTLING and other severe services such as blow-off, boiler feed, drip and drain lines, Crane recommends No. 16½P 150-Pound Brass Angle Valves. Crane alloy plug type disc and seat permit close regulation of flow; offer higher resistance to wire-drawing, corrosion, erosion, galling and scoring. Union or bolted bonnet, depending on size. Working pressures: 150 pounds saturated steam; 300 pounds cold water, oil, gas. Sizes: ⅛ to 3-inch. See your No. 49 Crane Catalog.

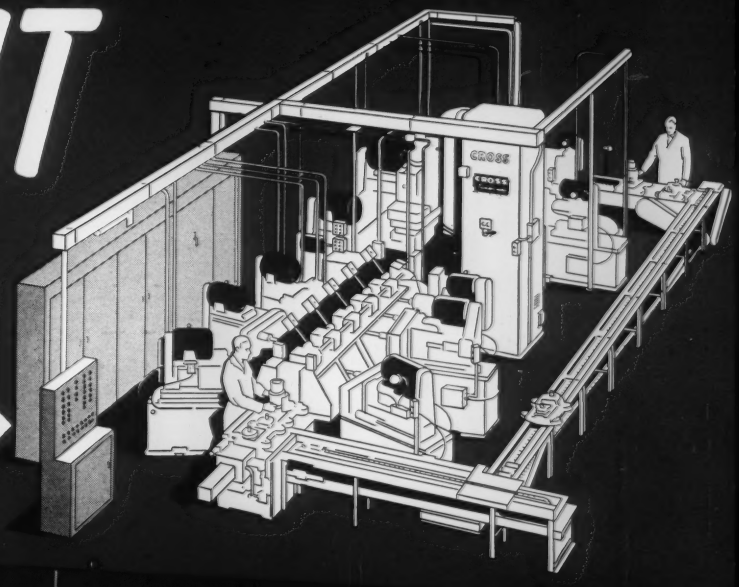
Amesteam Generator by Ames Iron Works, Oswego, N. Y.

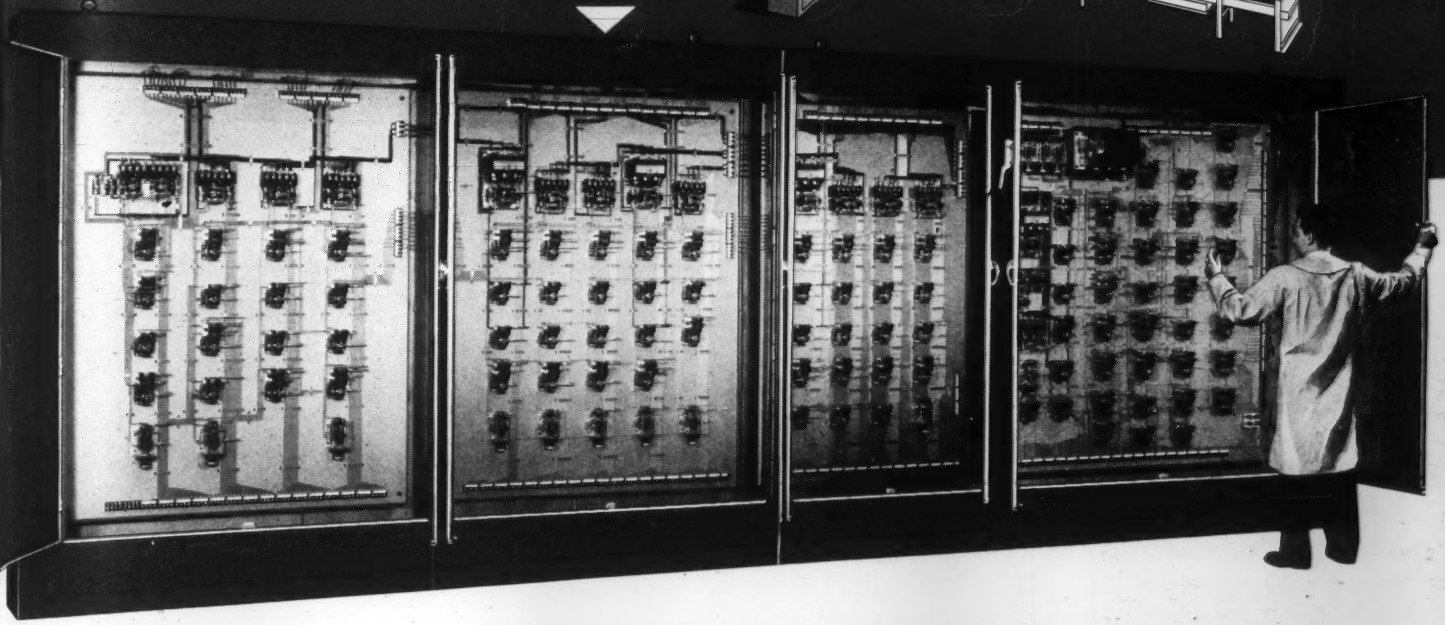
EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

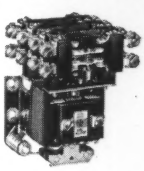
VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

120 UNIT CONTROL PANEL . . .

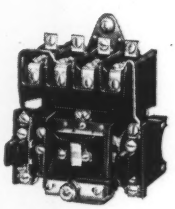




Panel Components



Bulletin 700 solenoid relay ... dependable ... consistent ... in closing and opening time.



Bulletin 709, Size 0, open type solenoid starter. Simple design assures trouble free operation.

Bulletin 709, Size 2, open type solenoid starter. A-B control is known for its reliable motor overload protection.

A-B Quality

...integrates the operating sequence of this huge production machine...

This marvel of complete automatic operation . . . is the Cross Transfer-Matic Machine for machining automobile transmission cases.

Over one hundred individual operations are co-ordinated into an automatic machining sequence. Obviously, split second, trouble free operation of the control is essential to justify the cost of such a machine.

All Allen-Bradley solenoid contactors on this control board have but one moving part. There are no links, levers, pins, pivots, or bearings to corrode, stick, or affect the time of operation. Such simplicity guarantees trouble free performance.

The overwhelming preference of machine tool builders for Allen-Bradley controls is easy to explain. No other controls are so trouble free. Descriptive bulletin will be mailed on request.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

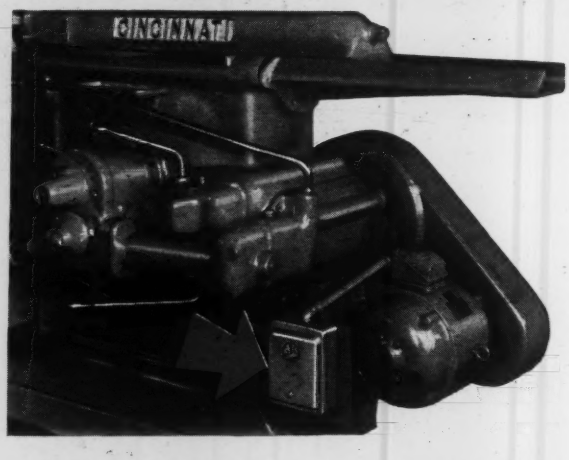
ALLEN-BRADLEY

SOLENOID MOTOR CONTROL

750-R

TROUBLE FREE CONTROLS

FOR SIMPLE OR COMPLEX SEQUENCE OPERATIONS



SINGLE MOTOR DRIVES—The Cincinnati Shaper Company furnishes, as standard factory equipment on these machines, an Allen-Bradley solenoid starter with a Start and Stop push button station near the operator. While this is a simple, one motor drive, the Allen-Bradley Bulletin 709 starter does more than merely start and stop the motor.

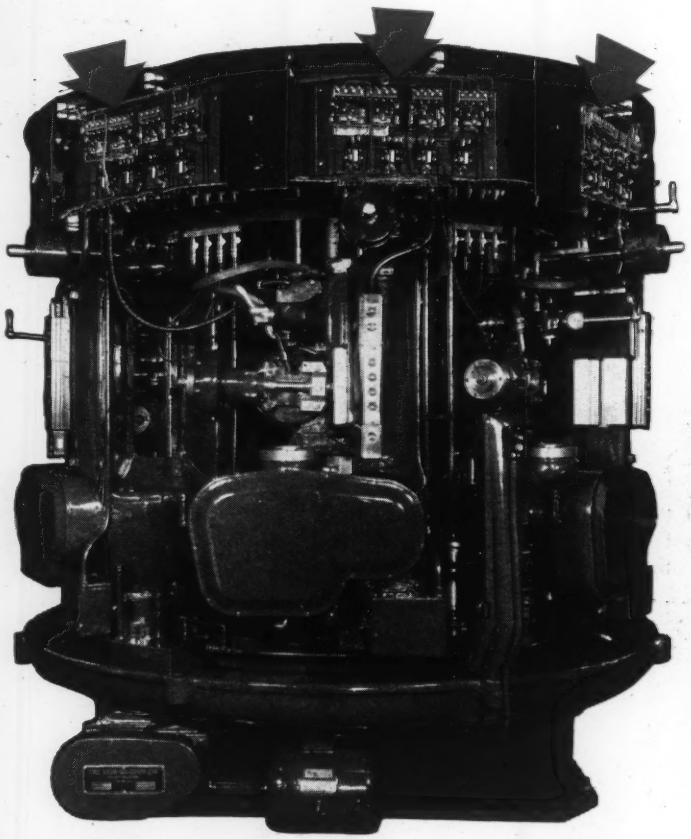
Accurate and dependable overload protection is provided by two Resistotherm overload relays in the starter. White interior makes inspection easier.

The "no voltage" protective feature of these starters prevents the motor and machine from re-starting accidentally after line or fuse failure.

Complete protection is assured for man, motor, and machine at all times.

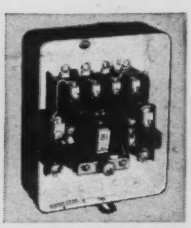
Keen machinery designers take full advantage of the precision performance and dependability of Allen-Bradley motor controls. The consistent timing of opening and closing provides precision co-ordination of machining operations. The result is increased output without loss of safety.

Let us show you, without obligation, how to use solenoid controls on your machines to best advantage.

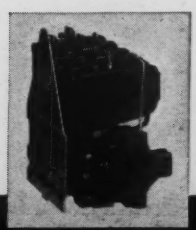


MULTI-MOTOR DRIVES—Lees-Bradner Company of Cleveland, Ohio, designed this 8-spindle gear hobbing machine with 27 electric motors. This automatic rotary tool required a complex system of automatic sequence controls. In the illustration, above, are shown some of the control panels around the top of the machine. The total control system required 118 Allen-Bradley starters, relays, limit switches, and push buttons.

Leading machine tool builders have standardized on Allen-Bradley solenoid controls, because they are so dependable and trouble free.



Allen-Bradley motor starters are available in various enclosures such as general purpose, water-tight, dust tight.



Allen-Bradley switches and starters are self insulated, and can be grouped closely in gangs on metal panels or in machine bases.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. 750-R

A-B Quality

ALLEN-BRADLEY

SOLENOID MOTOR CONTROL

QUALITY

The Magic Touch that Increases Sales!

The Ekotape Pla-mate (Model 109) manufactured by Webster Electric Co., Racine, Wis., on which the die castings illustrated are standard equipment.

Proper Material Selection gets close attention by the technical staff at Webster Electric. After the careful screening of all possibilities they decided on Madison-Kipp die castings for strength, lightness, eye appeal and value.

When you plan new products requiring metal parts, please keep us in mind. Please also remember to send full data to our home office in Madison.

MADISON-KIPP CORPORATION

210 WAUBESA STREET, MADISON 10, WIS., U.S.A.

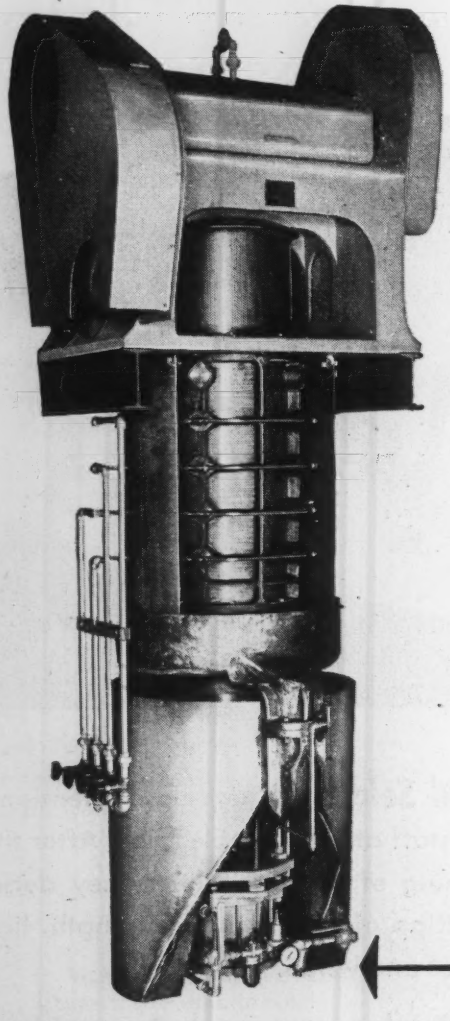
ANCIENS ATELIERS GASQUY, 31 Rue du Marais, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS

Norgren units help put *Continuous* in

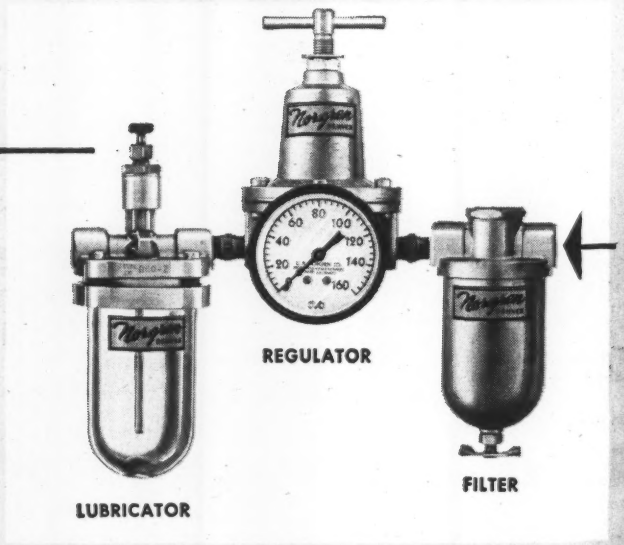
JACKSON & CHURCH CONTINUOUS PULP PRESSES



An air-controlled FLOATING CONE beneath a vertical screw-type press-spindle automatically maintains a a pre-selected constant counter pressure against the force of the pulp feed, ***regardless of the rate of feed.*** Results: higher liquid separation; greater recovery yield of marketable by-products; no overloading; no attention required.

J & C selected the Relieving Type Norgren Pressure Regulator with its sensitive and accurate air regulation to give automatic and continuous control over the performance of their "Zenith" pulp press. Customers report no servicing required even after years of 24-hour service—much of it 7 days a week. Simple in design—rugged in construction and remarkably efficient in operation.

The Norgren Lubro-Control Unit includes Air Filter, Regulator and Lubricator. Filtered air prevents scored cylinders and damaged packings. Norgren oil fog lubrication of the cylinder is assured by simply operating the cylinder over its full 6" stroke several times, once a week—replacing inefficient, manual lubrication and improving cylinder performance and life.



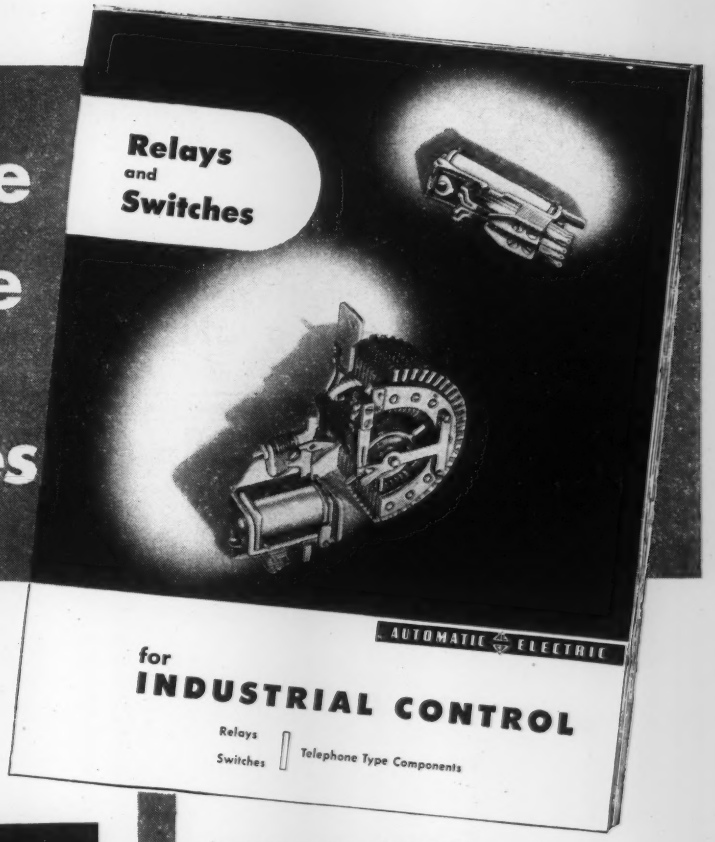
MORAL When YOU have special problems demanding cleaner, better regulated air power and automatic lubrication of air powered equipment—CHECK WITH NORGREN.

Get all the details described in Norgren Blueprint # 104. Write C. A. Norgren Co., 242 Santa Fe Drive, Denver 9, Colo.

Norgren

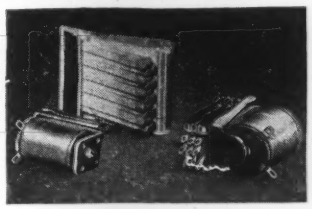
Filters, Regulators, Lubricators, Valves, Hose Assemblies

Ask for this 88-page technical guide to the use of relays and switches



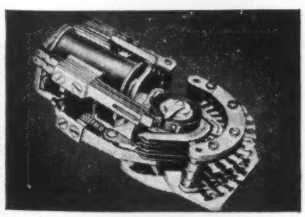
relays

Class "B" Relays—For extremely high speed operation and for time delays on either "operate" or "release" strokes. Available for either d-c or a-c operation.

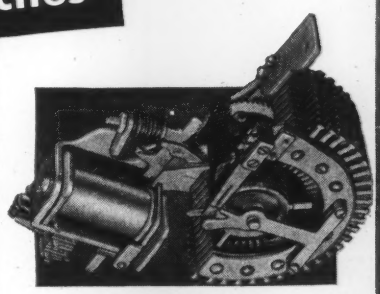


Class "S" Relays—Astonishing power in a small, light weight relay. Hermetically sealed if desired. Unaffected by vibration, temperature, humidity. Coils up to 10,000 ohms or more.

switches



Type 44 Stepping Switch—For d-c operation, tiny, light weight. Accommodates up to 6 bank levels with 10 points plus "home." Adaptable to 10-, 20- or 30-point operation.



Type 45 Stepping Switch—For d-c operation, or supplied with built-in rectifier for a-c operation. Accommodates up to 10 or more bank levels. Adaptable to 25- or 50-point selection.

AUTOMATIC ELECTRIC
CHICAGO

Catalog No. 4071-F

For any product — for any purpose where you need relays or stepping switches—there is an Automatic Electric unit that's exactly RIGHT. Only a few are shown at the left, but all are illustrated and described in our big new catalog 4071-F.

Here are complete specifications and performance and mounting data on the wide range of components manufactured by Automatic Electric Company for communication, signaling, and industrial electrical control service. Here you'll find units for *your* jobs—including hermetically sealed and low-capacitance relays, and the most compact stepping switch on the market! Write for your copy of this new catalog. Address: AUTOMATIC ELECTRIC SALES CORPORATION, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric (Canada) Ltd., Toronto. *Offices in Principal Cities.*

Automatic Electric Sales Corporation
1033 West Van Buren Street
Chicago 7, Illinois

Gentlemen:
Please send me a copy of Catalog No. 4071-F. I am attaching my business letterhead and address.

Name _____

Title _____

Company _____

TORQUE AT ZERO SLIP

...plus 7 other outstanding clutch advantages

with a VICKERS Magneclutch*

Illustrated is a Magneclutch designed for high power slip service.

NEVER BEFORE in clutch history has *one* product offered all these design and operating features! Check them against your clutch requirements for SLIP SERVICE... BRAKING... ON-OFF or TORQUE SERVICE... TORQUE LIMITING... REVERSING DUTY.

Dry magnetic torque
Large maximum to minimum torque
Virtually no wear on torque transmitting surfaces
Fast response
Small control power
Easily adapted to remote control
Electrically controlled

VICKERS ELECTRIC DIVISION

VICKERS Inc.

LINDE'S News of Metalworking

$$$$$$ Saved in Removal of Blast-Furnace Salamander

Oxy-acetylene powder-cutting eliminated a nasty job in one steel mill not long ago. The problem was to remove a salamander in a blast furnace so that the hearth could be replaced without disturbing the upper lining.

After discussing the problem with a LINDE Process Service representative, the company decided to use powder-cutting with an OXWELD C-60 Blowpipe to cut up the salamander.

Only three days were required for the cutting. Production time saved over any other removal method was estimated to be two weeks. $500,000 worth of iron can be produced in two weeks' time.

Most important from the mill's standpoint was the fact that the upper brickwork was not damaged. Damage from other methods of removing the salamander could run as high as $300,000 worth of brickwork.

The OXWELD C-60 Blowpipe is specially designed for extra heavy cutting. And when powder-cutting is used refractory oxides are no problem.

What's News

► Of special interest to quarry men is LINDE'S Jet-Piercing blowpipe which can pierce holes to a depth of 5 ft. in hard and abrasive rocks and ores. This economical, speedy method makes blast holes in granite at a rate of 22 to 25 ft. per hour.

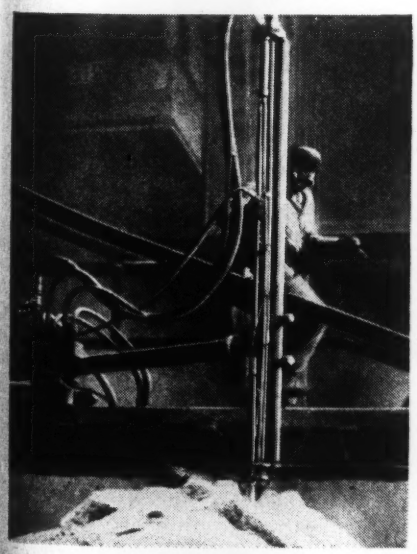
► One pipe manufacturer has produced a record seventy miles of 24-in. pipe (12,990 tons) in one month with the help of UNIONMELT welding.

► By using oxy-acetylene flame-cleaning, a foundry has cut the time required to clean slag from the center of their 20-in. castings from about 6 hours to 5 minutes.

► When television inspectors rejected ten thousand tubes because of cracks in the spun chrome steel bases, LINDE engineers showed the tube manufacturer how to make repairs by HELIARC welding. A saving of $8.00 per tube was accomplished.

LINDE Service Doesn't Cost -- It Pays!

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto



Powder-cutting is used for many jobs in addition to the salamander cutting described above. It is ideal for reducing large masses of cast iron.

"Lost Heat" Reclaimed in 18 Hours

When a full 75-ton heat of steel was recently lost through the bottom of an open-hearth furnace, it was reclaimed in only 18 hours. An OXWELD C-60 Cutting Blowpipe quickly cut the metal to handling size. Using older methods this would have been a three-day task.

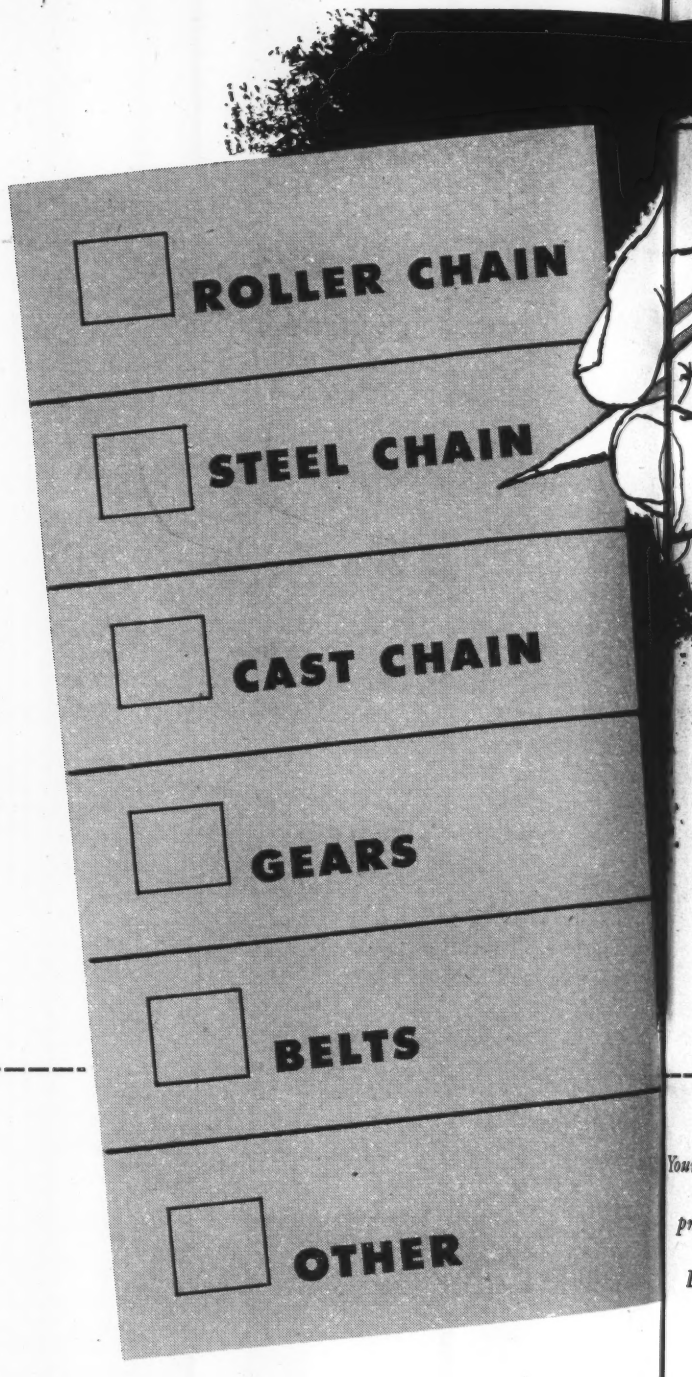
Two full days of operating time were saved by returning the furnace to service in 18 hours. Actual cutting time was only five hours.

And the expense? Total cost for materials amounted to not more than $100.

For further information about powder-cutting or other LINDE processes, call or write our nearest office. We'll be glad to give you more details.

Slag and cinder inclusions are no problem for the C-60 and powder-cutting. Spill sections as thick as 6 ft. have been severed by continuous cutting.

The terms "Linde," "Oxweld," "Unionmelt," and "Heliarc" are registered trade-marks of Union Carbide and Carbon Corporation or its Units.



Have you made the right choice?

. . . if you're designing for lower cost!

Let's consider your power transmission equipment. You know that substantial savings in first cost . . . in operating cost . . . in overall cost can be realized through proper selection and application of power transmission equipment in your machines.

There is no one best method for all equipment. BUT there is a *right* answer to *each* machine for driving, timing and conveying. In the complete Chain Belt line, you can find an answer to the vast majority of applications. Because they are not handicapped by the limitations of a limited line, Rex Field Sales Engineers can help you select the exact type of chain that is right for your machines . . . for lower costs all along the line.

Perhaps you have been using a finished roller chain, yet speed and load conditions are such that a cast chain or double-pitch roller chain will operate equally well at lower initial costs.

Perhaps you have been using a cast chain, yet speed requirements demand a roller chain for efficient operation. It may be that your machine demands exact timing *throughout its life.* Only finished roller chain will answer this need.

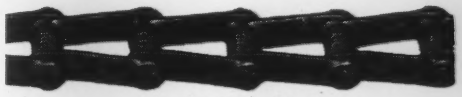
Your equipment may be required to operate in dusty, dirty conditions. Chabelco Steel Chain can save you and your customers money here.

You may be using too heavy a chain for the service conditions under which your machine is to operate. The Rex Man will help you select the right chain that will do the job effectively at lower cost.

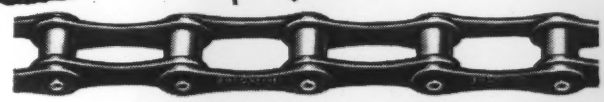
The complete Chain Belt line provides a chain to exactly suit virtually every application. In those instances where belts or gears may be better, the Rex Field Sales Engineer can tell you why you should use these mediums for best results.

Chain Belt Company OF MILWAUKEE

Baldwin-Rex Standard Roller Chain

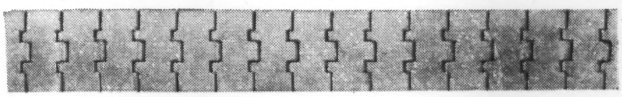


Rex Cast Pintle Chain



Baldwin-Rex Double Pitch Roller Chain

Rex Chabelco Steel Chain



Rex TableTop® Conveyor Chain

Baldwin-Rex Leaf Chain

Your Rex Field Sales Engineer will be happy to consult with you regarding your application problems. He may be able to help you make substantial savings. Call or write your nearest Field Sales Office. Or, if you prefer, mail the coupon.

CHAIN BELT DISTRICT SALES OFFICES

Atlanta	Dallas	Los Angeles	Pittsburgh
Birmingham	Denver	Louisville	Portland
Boston	Detroit	Midland	St. Louis
Buffalo	Houston	Milwaukee	San Francisco
Chicago	Indianapolis	Minneapolis	Seattle
Cincinnati	Jacksonville	New York	Springfield
Cleveland	Kansas City	Philadelphia	Tulsa

REX STOCK-CARRYING WAREHOUSES

Atlanta	Milwaukee	Seattle
Dallas	Portland	Springfield
Los Angeles	San Francisco	Worcester

DISTRIBUTORS THROUGHOUT THE WORLD

REX

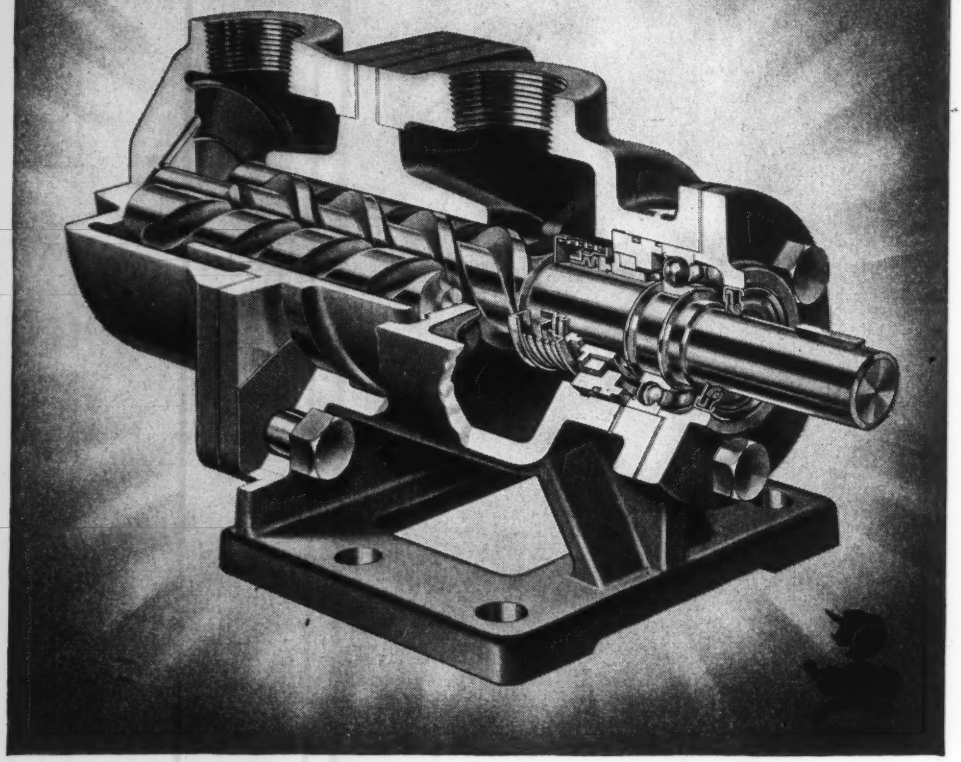
® BALDWIN-REX

REX CHAIN & TRANSMISSION DIVISION
Milwaukee 4, Wisconsin

BALDWIN-DUCKWORTH DIVISION
Springfield 2, Massachusetts

Chain Belt Company 51-104
1643 W. Bruce Street
Milwaukee 4, Wisconsin
Gentlemen:
I am particularly interested in.....
.....
Please send me descriptive literature.
Name.....
Company.....*Dept.*.....
Address.....
City.....*State*.....

PUT THIS New Low Cost IMO ON YOUR OIL LINES!



I-161R

Now you can have all the advantages of the IMO: high speed operation—quietness—freedom from vibration—simplicity—reliability—at less cost than ever before.

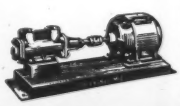
Look at the cross-section and you will see why no other pump is quite so well suited for oil handling service.

The axial flow design permits oil to be pumped close to the rotating axis of the rotors. This means low liquid velocity and quiet operation at high speeds.

Large inlet areas provide smooth entrance of liquid into the pump and permit the handling of high viscosities at high suction lifts.

The A313A IMO has no stuffing boxes to leak or require packing, and best of all, it can be mounted in any position and be directly connected for operation at motor speeds.

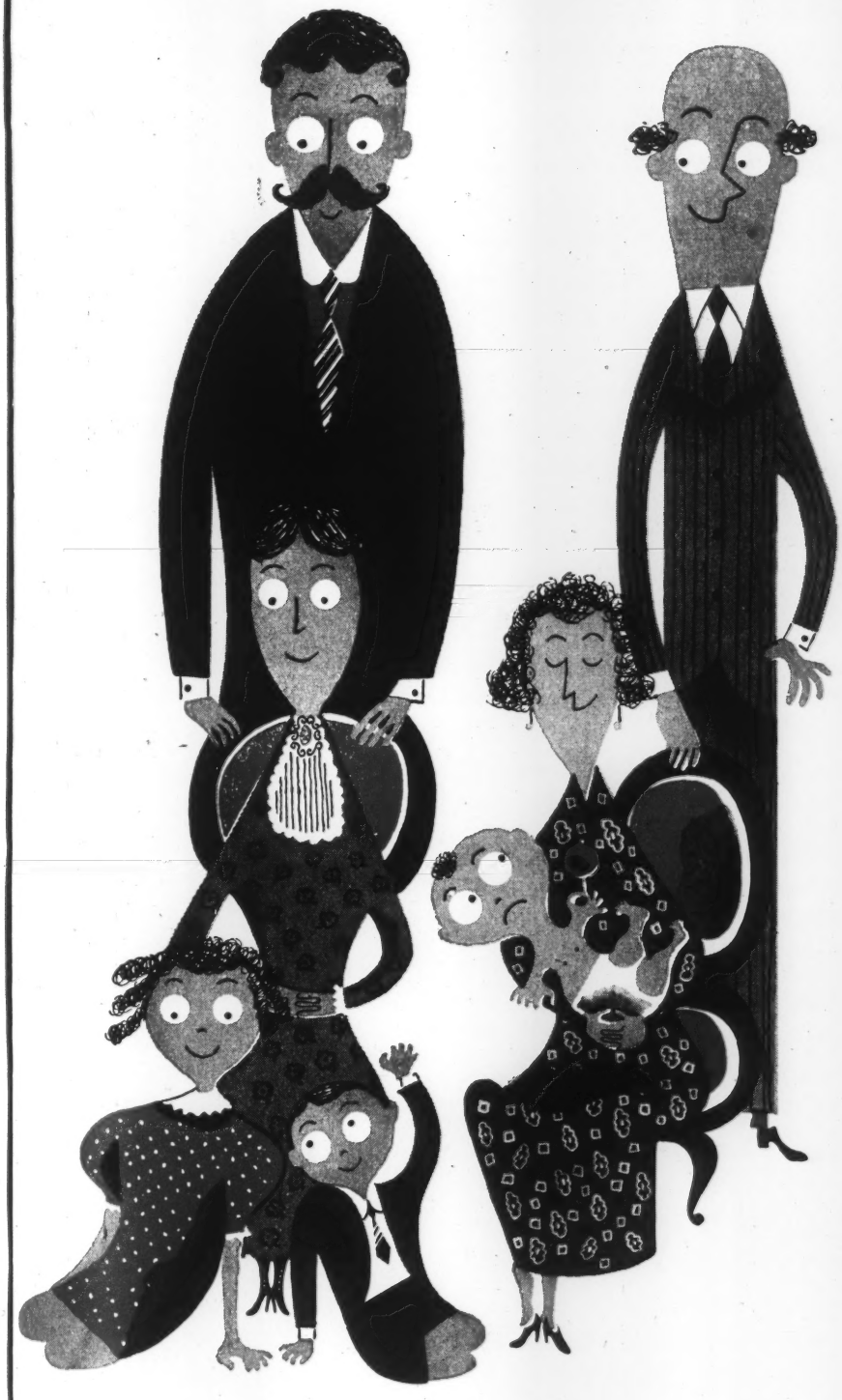
For your next oil handling job, be sure of the best . . . specify the new low cost A313A IMO pump. Ask for Bulletin I-161R-D.



IMO-DELAVAL PRODUCTS DIVISION

DeLaval Steam Turbine Company, Trenton 2, New Jersey

DE LAVAL



stainless steel is a family affair

There's more than just one type of stainless steel . . . because *stainless* applies to a family of steels. And in order to get the best possible results from stainless in your application, the *right* analysis must be used.

That's why Crucible, a pioneer in the development of this specialty, offers you the services of an alert staff of metallurgists to help you with your stainless application problem.

Crucible's half century of specialty steel leadership is built on a strong foundation of service to Industry . . . with attention to detail . . . whether the order is in tons or pounds. From the ground up, Crucible designed and put into operation one of the first integrated mills built specifically to hot and cold roll stainless steel. This $18,000,000 addition gives Crucible facilities to provide industry with stainless in every form.

There is no substitute for Crucible's background of 50 years of specialty experience. Let Crucible show you how to apply stainless steels to your products. One call from you puts us to work on your application.

CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, N. Y.

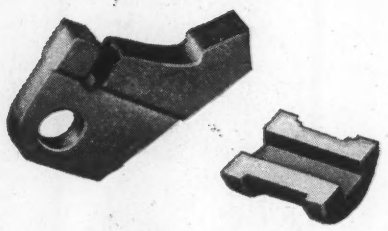
CRUCIBLE first name in special purpose steels

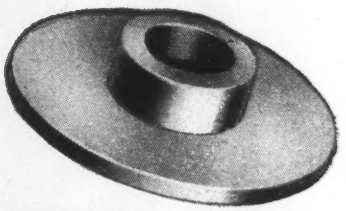
STAINLESS STEELS

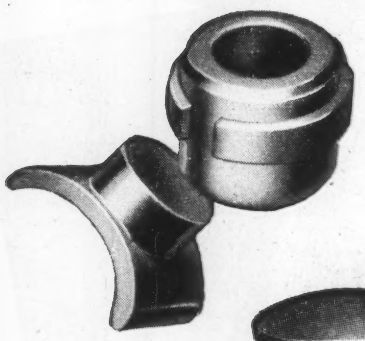
STAINLESS • HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE • STEELS

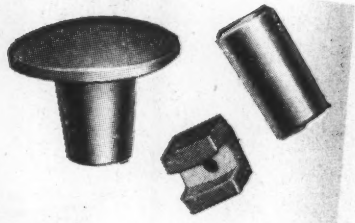
Will Gladly Accept your Order...

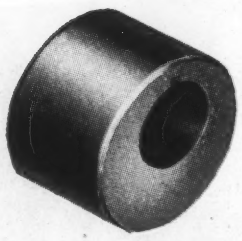
Subject to a Great Big IF

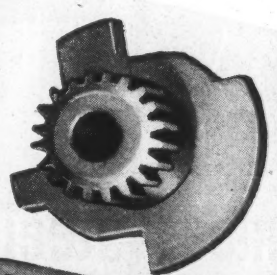












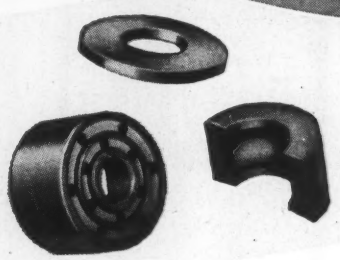
Engineering knowledge, tooling, and production know-how, coupled with the most modern equipment available, are what it takes to produce quality parts made from metal powders—and Moraine has all these in full measure. Naturally, we seek your order, provided we are convinced that the metal powder process will work to *your* advantage—in lowered costs and better performance.

Ask Moraine whether parts you are using can advantageously be produced by powder metallurgy. We'll gladly accept your order—

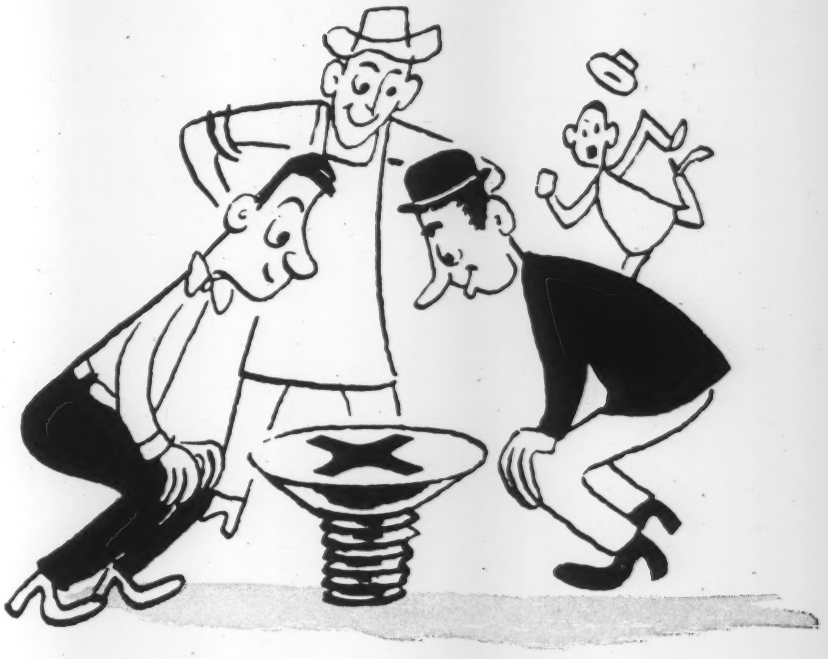
- **IF** the shape of the part permits good die fill and correct density . . .
- **IF** its required physical properties and tolerances can be obtained by our normal production methods . . . *and*
- **IF** it is to be made in quantities sufficient to justify tooling costs, set-up, and equipment loading.

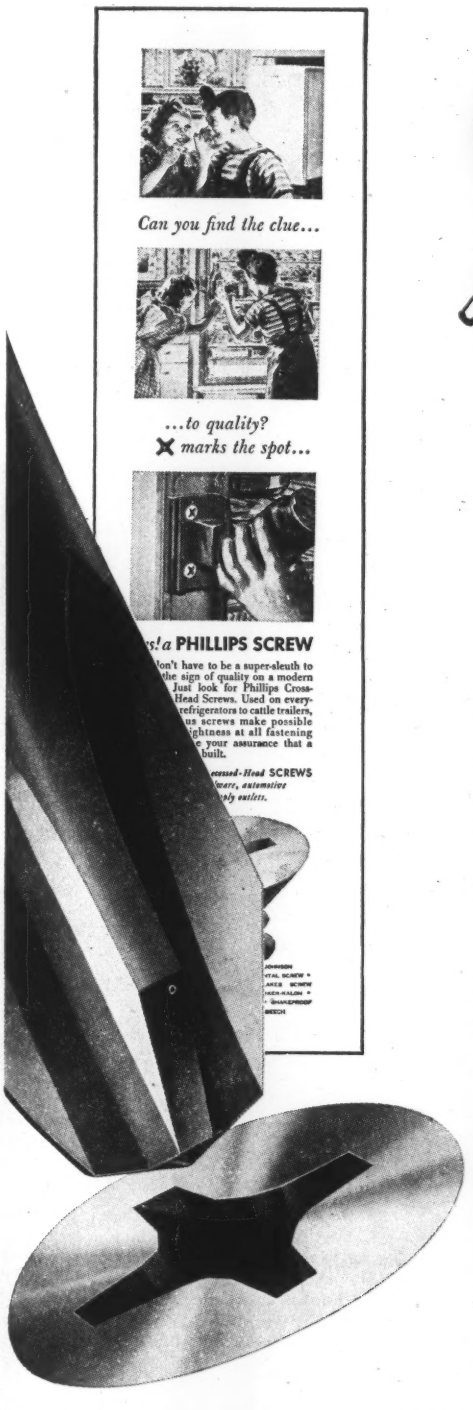
Those are the three big IF's . . . and here's another just as important: IF we accept your order, you can be sure, in advance of delivery, that Moraine parts will justify your interest and may reduce your manufacturing costs.

METAL POWDER PARTS BY MORAINE



MORAINE PRODUCTS
DIVISION OF GENERAL MOTORS
DAYTON, OHIO





Does your product have this clue to quality?

Use of Phillips Screws proves extra care in manufacture

Production men know. Design engineers know. Purchasing agents know. AND NOW THE PUBLIC KNOWS that . . .

X marks the spot . . . the mark of *extra* quality. The identifying X formed by the cross-recess on the head of every Phillips Screw.

14 million readers of The Saturday Evening Post are being urged to look for this clue to quality in modern, well-built products.

Phillips Screws make your product stronger, better looking. They eliminate jagged burrs, split screw heads, make production power driving possible. Whether you use Phillips wood screws, machine screws or tapping screws you gain time, money, work-hours.

◀ Current advertisement on Phillips Screws appearing in The Saturday Evening Post.

PHILLIPS *Cross-Recessed-Head* **SCREWS**

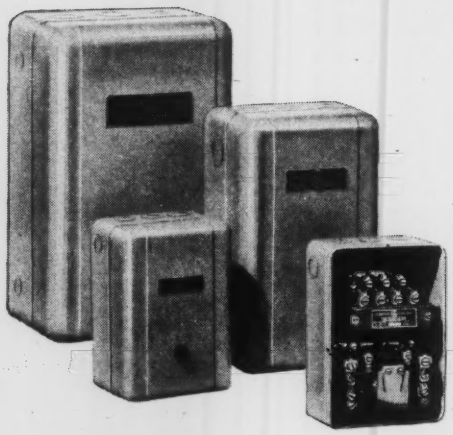
X marks the spot... the mark of extra quality

AMERICAN SCREW CO. • THE BLAKE & JOHNSON CO. • CAMCAR SCREW & MFG. CORP.
CENTRAL SCREW CO. • CONTINENTAL SCREW CO. • ELCO TOOL & SCREW CORP.
GREAT LAKES SCREW CORP. • THE H. M. HARPER CO. • NATIONAL LOCK CO. • PARKER-KALON CORP.
PHEOLL MANUFACTURING CO. • ROCKFORD SCREW PRODUCTS CO. • SCOVILL MANUFACTURING CO.
SHAKEPROOF INC. • THE SOUTHINGTON HDWE. MFG. CO. • WALES-BEECH CORP.

THE FASTENERS OF TODAY . . . AND OF THE FUTURE

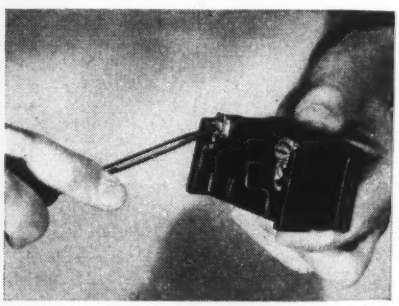
Designer's

IN DEMAND—because they last longer!



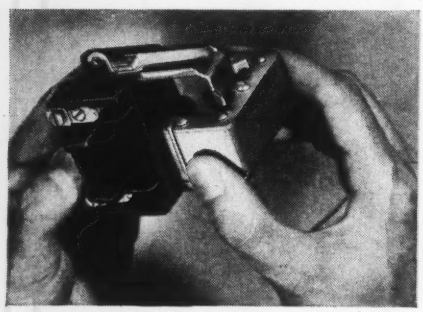
One thing your machinery customers want in a starter is long life and without expensive maintenance, too. That's why they prefer General Electric a-c magnetic starters, built to last longer than any other you can buy! Get the full story in Bulletin GEA-5153.

1 Note the coil! It's the G-E "strongbox" magnet coil, two to five times longer-lasting than conventional coils. Windings can't be damaged by a slipping screwdriver because they're locked in a molded plastic block.



2 Note the terminals! Permanently anchored in the coil enclosure, they can't work loose, even after years of operation. And note, too, that they're located on the front of the coil. Makes servicing easier, faster.

GE Motor Starters



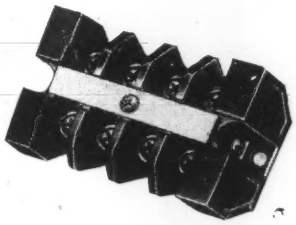
3 Note the magnet! Even after it's been in service for years, it moves smoothly back and forth, thanks to the permanent "molded-in" lubricant in the plastic coil block. There's no metal-to-metal friction, no bearings to wear.

4 Note the contacts! Made of fine silver, they'll stand up even in toughest "start-stop" service. High initial tip pressure leaves little chance of their welding together. And arc hoods keep each tip protected.

GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS



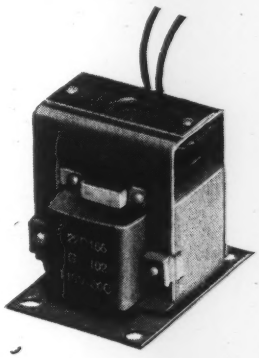
NEW TERMINAL BOARD

—to simplify control wiring

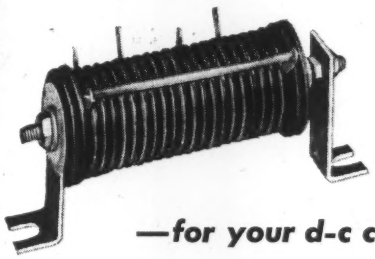
This new General Electric EB-5 fabricated terminal board has washer-head connection screws to speed the job of wiring, testing and checking your circuits. Rated 600 volts, 30 amperes, it's made in 4-, 6-, 8-, and 12-terminal units, to accommodate wire sizes AWG 18 to 10. Reversible, black-and-white plastic marking strips facilitate wire identification. See Bulletin GEA-1497.

SHORT-STROKE SOLENOIDS

—with long-life features



Here's a new General Electric push-type solenoid—for strokes up to $\frac{5}{16}$ inch—built for long life under heavy pounding and rapid duty-cycle operation. One reason for its durability is the rock-hard plastic block encasing the coil and protecting it against moisture, oil, shock and vibration. Others include new riveted magnet structure, stainless steel backstop, and heavy, brazed-on baseplate. See Bulletin GEC-692.



METALLIC RECTIFIERS

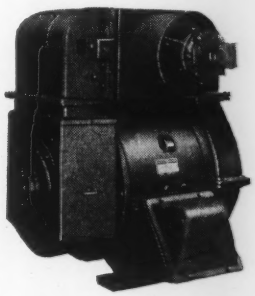
—for your d-c control needs

Convenient conversion of control power from a-c to d-c calls for a General Electric metallic rectifier. Whatever your particular need, meet it with a high-voltage selenium, low-voltage selenium, or copper-oxide type from the complete G-E line. Where high efficiency, uniformity and space economy are all-important, use the new high-voltage selenium rectifier cell shown. See Bulletin GEA-5280.

Dust and dirt can't stop them!

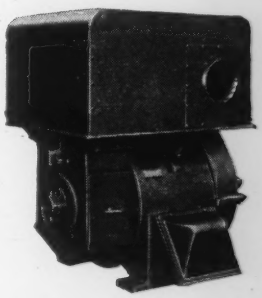
UNIT-COOLED D-C MOTORS

On large machine tools in dusty, dirty or oil-laden atmospheres—that's the place for General Electric totally enclosed, unit-cooled d-c motors. Completely factory-assembled, they save installation time and extra equipment cost. No need for specially built motor room, piping, ductwork, coolant, external filters, or pressurized air supply. Ratings from 15 to 200 hp. See Bulletin GEA-4469.



Single-blower type

For constant-speed or normal adjustable-speed operation—has shaft-driven fan to circulate internal air, and separate motor-driven blower for external air.



Double-blower type

For continuous operation at speeds below normal—uses one auxiliary motor to drive blowers for both internal motor air and external cooling air.

General Electric Company, Section A668-86
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ☑ for reference purposes
- ☒ in connection with immediate projects
  - ☐ GEA-1497 Terminal boards
  - ☐ GEA-4469 Unit-cooled d-c motors
  - ☐ GEA-5153 A-c motor starters
  - ☐ GEA-5280 High-voltage selenium rectifiers
  - ☐ GEC-692 Short-stroke solenoids

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS!
You'll find "everything electric" for machinery manufacturers in the General Electric section.

NAME_____

COMPANY_____

STREET_____

CITY_____ STATE_____

PHILLIE GEAR

makes them all

HYPOIDS, ZEROLS, CURVED TOOTH SPIRAL-BEVELS

These gears assure smoothness, quietness, efficiency, strength and durability.

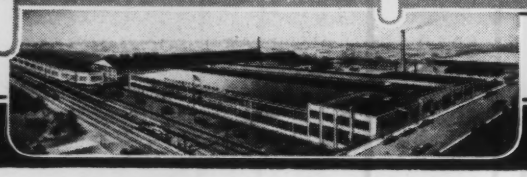
Teeth of Hypoids are oblique and curved, engaging gradually from one end to the other with continuous contact at pitch line, at least two pairs of teeth always in contact.

Zerol Gears are curved-tooth bevel gears with zero degree spiral angle. They combine localized tooth contact of spiral bevel gears with low thrust loads of straight bevel gears.

Curved Tooth Spiral Bevel gears are unequaled for High Ratio, High Speed Drives where sizes must be kept to a minimum. All are available in sizes up to 48" diameter.

For more complete details on these and other Philadelphia Gears, send for the "Gear Book." Please write on your Business Letterhead.

Philadelphia Gear Works, INC.



ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

stop coupling failures!

FIND OUT HOW *Koppers Engineers Eliminate Needless Downtime* IN YOUR PLANT!

These FAST'S COUPLING *Services save you money!*

UNSURPASSED ENGINEERING . . . Koppers engineers are acknowledged the best in the industry. Their practical knowledge, backed with 30 years' coupling experience, is at your service!

IMMEDIATE DELIVERY . . . All standard types and sizes are available for immediate delivery from "on hand" stocks. In case of emergency, just wire factory for special rush delivery!

LOWEST COST PER YEAR . . . Fast's Couplings will outlast equipment they connect if properly maintained. Their cost may be spread out over 25 years or more, offering you lowest coupling cost per year!

Before your plant is harassed by needless coupling failures—*call on Koppers!* Only Koppers offers you a two barreled solution to coupling problems: Fast's Couplings, the original gear-type coupling—and Koppers Engineering Service, acknowledged the finest in the industry!

For *30 years,* Fast's Couplings have been industry's standard for *long life* at *low cost.* Now, in addition, when you specify Fast's you get the *extra* advantage of Koppers valuable Engineering Service. Koppers engineers, backed with 30 years of Fast's Coupling experience, study your problem. Then show *which* Fast's Coupling you need (and more important) *why you need it!*

Only Koppers can offer you both Fast's Couplings and unexcelled engineering service—so before you buy *any coupling,* get the complete story on Fast's. Full details are contained in the Fast's Catalog. For your free copy, send the coupon today!

KOPPERS

30th Anniversary FAST'S Couplings 1920-1950

FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

Send for

FREE CATALOG

KOPPERS CO., INC., *Fast's Coupling Dept.,*
342 Scott St., Baltimore 3, Md.

Please send me a copy of Fast's Catalog relative to.....
.....(type of industry).

Name.....

Company.....

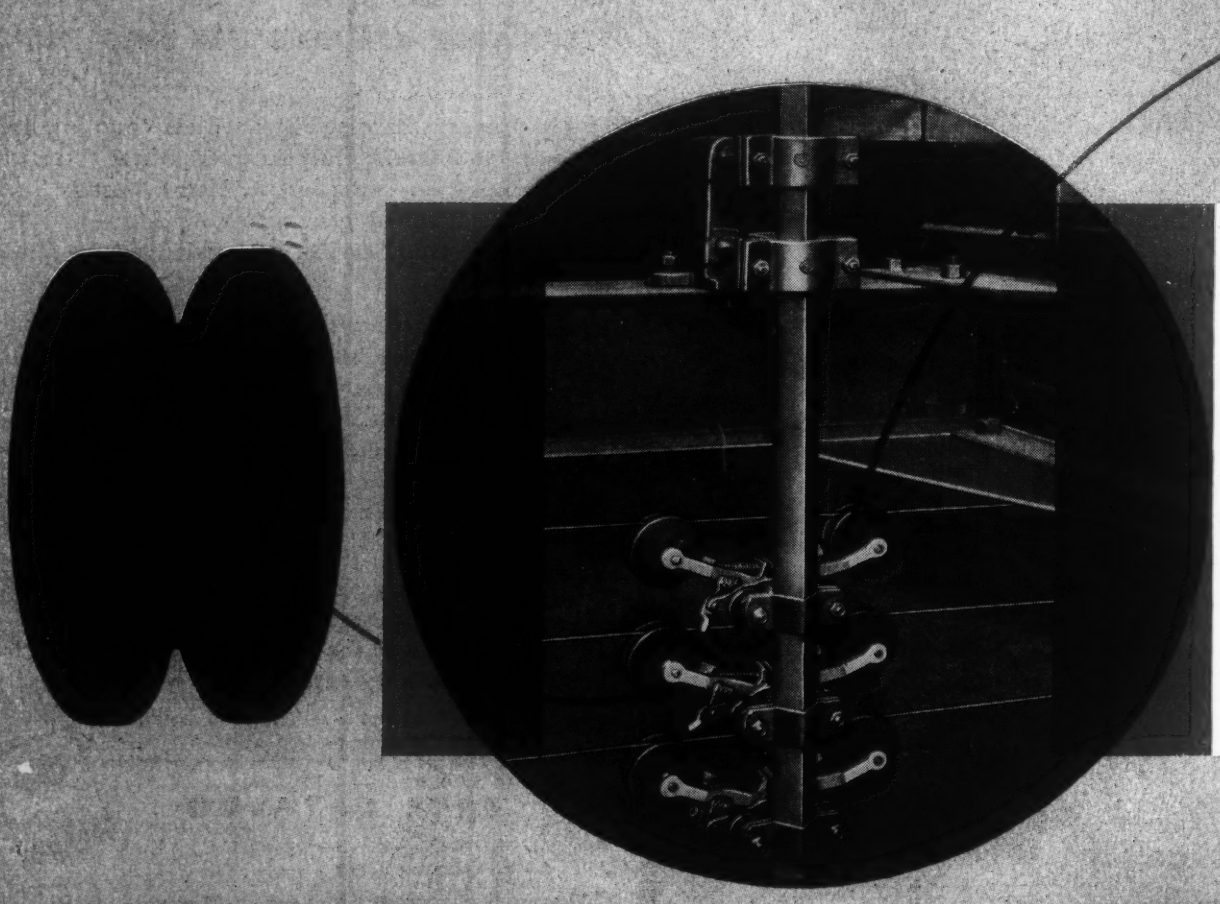
Address.....

City.....Zone.....State.....

WHITING ELECTRIC TRAVELING CRANES increase their efficiency with GRAPHITAR

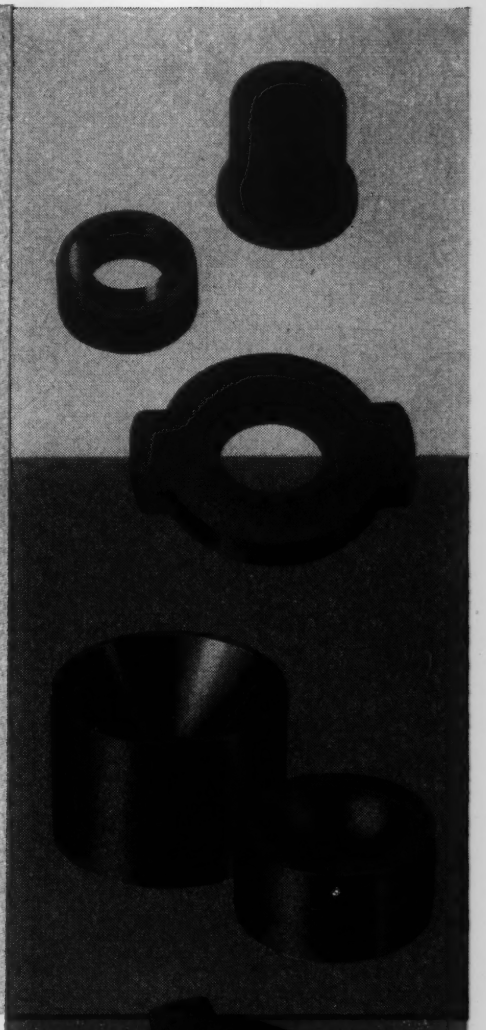
(CARBON-GRAPHITE)

There's more than one good reason why the Whiting Corporation of Harvey, Illinois uses Graphitar current-collector wheels on their overhead traveling electric cranes. They have found that Graphitar can be counted on to give long, trouble-free performance and increase the efficiency of the powerful Whiting cranes. Graphitar is a self-lubricating material, a fact that makes bushings unnecessary and banishes trolley wire greasing necessary with other collector-wheels. Graphitar has great wear resistance which means less collector-wheel replacements. Graphitar wheels virtually eliminate pitting, arcing and burning. Current-collector wheels are just one of many applications of Graphitar as an extremely useful industrial material.



THE UNITED STATES

CURRENT-COLLECTOR WHEELS

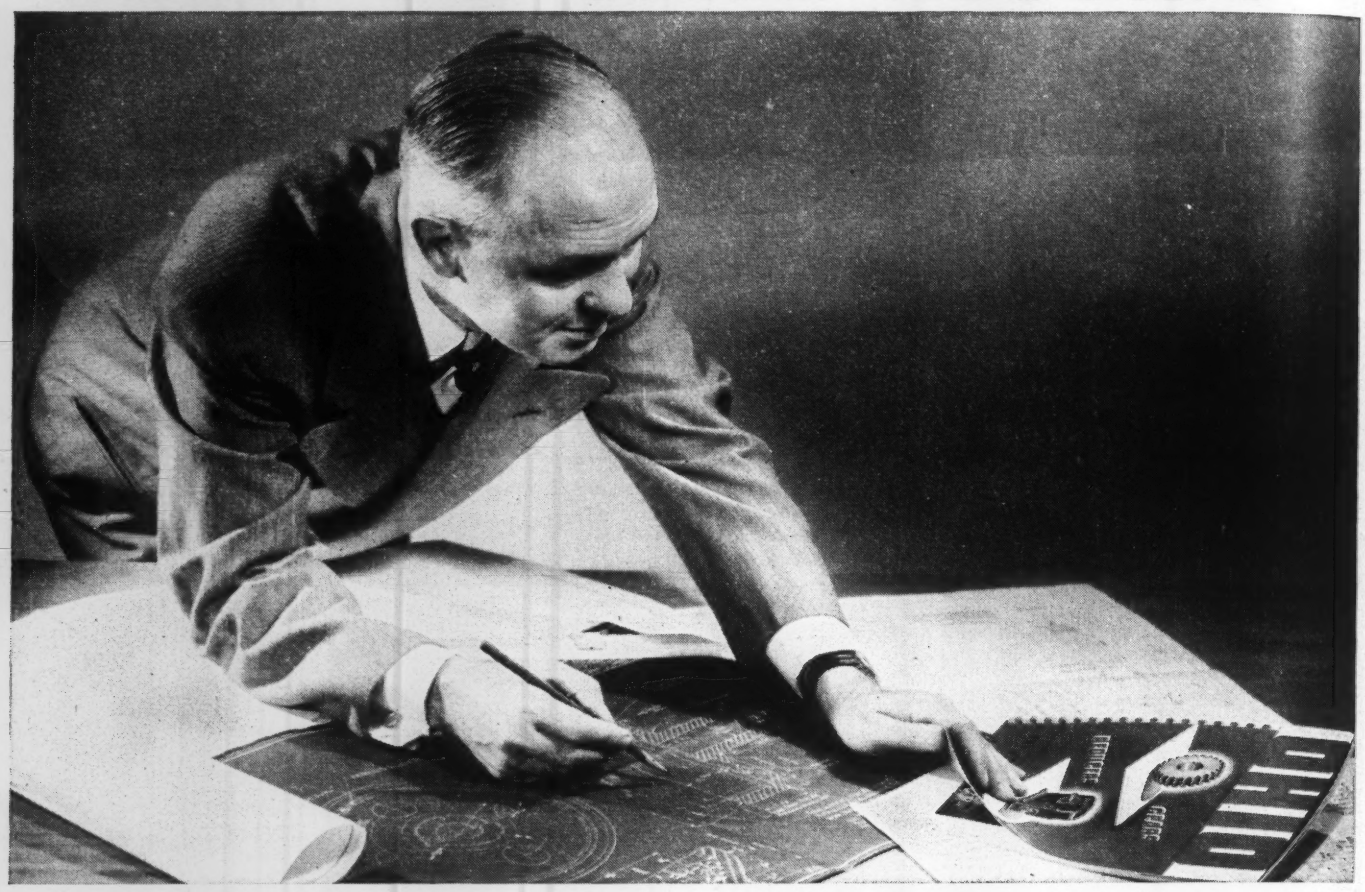


GRAPHITAR® is finding its way into scores of new uses because of its many unique and valuable characteristics. Graphitar is chemically inert . . . practically unaffected by extreme temperatures and is self-lubricating under all conditions. It is extremely light yet mechanically strong. It can be molded into seals, bearings, bushings, rings and other parts . . . it can be ground to tolerances as close as .0005″ in smaller sizes. It is available in many different grades to meet particular specifications and working conditions. Our engineers will be glad to study your sketches and perhaps suggest ways in which Graphitar can improve the efficiency of your operations. Ask for the new 64 page Graphitar catalog.

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

HOW TO SAVE MONEY*



DISTRIBUTORS AND REPRESENTATIVES

*Akron, Ohio
Hardware & Supply Co.
*Baltimore, Md.
L. A. Benson Co., Inc.
*Brooklyn 6, N. Y.
(Gears) Northside Leather Belting Co., Inc.
Buffalo, N. Y.
F. E. Allen
*S. H. Pooley Belting Co.
Chicago 7, Illinois
Schrade-Batterson Co.
Cleveland 2, Ohio
J. A. Schomer Co.
Dayton, Ohio
E. C. Hawk
*Detroit 2, Michigan
Abrasive and Supply Co.
*Erie, Pa.
Crossley Co.
*Findlay, Ohio
Bearing & Transmission Co.
*Grand Rapids, Mich.
F. Raniville Co.
*Hagerstown, Md.
Hagerstown Equipment Co.
Hoboken, N. J.
Crown Industrial Supply
Houston 3, Texas
Behring's Bearing Service, Inc.
*Indianapolis, Indiana
A. R. Young
*Kansas City, North, Mo.
Sesco Engineering & Supply Corp.
*Los Angeles, Calif.
J. W. Minder Chain & Gear Co.
Louisville 2, Ky.
Alfred Halliday
*Memphis 2, Tenn.
Memphis Bearing & Supply Co.
*Miami 9, Fla.
General Equipment & Supply, Inc.
Milwaukee 11, Wisc.
Albert F. Korf & Co.
*Minneapolis, Minn.
Industrial Supply Co.
*Muskegon, Mich.
Lake Shore Machinery & Supply Co.
*New Orleans, La.
(Gears) R. J. Tricon Co.
(Reducers) Woodward Wight & Co.
*New York, N. Y.
(Reducers) Patron Transmission Co.,
(Gears) Atlantic Gear Works
*Paterson 4, N. J.
(Gears) Bernstein Bros. Inc.
Pawtucket, Rhode Island
George G. Pragst
*Philadelphia, Pa.
Rothman Belting & Equipment Co.
Robert L. Latimer Co.
*Piqua, Ohio
Bornell Supply Co., Inc.
*Pittsburgh, Pa.
Standard Machinists Supply Co.
*Portland, Oregon
J. W. Minder Chain & Gear Co.
*Rochester 4, N. Y.
H. M. Cross and Sons
*San Francisco, Calif.
The Adam Hill Co.
*St. Louis, Mo.
The Essmueller Co.
*Syracuse, N. Y.
U. and S., Inc.
*Toledo, Ohio
The Bearing & Transmission Co.

IN CANADA, *Montreal, Quebec, John Braidwood & Sons, Ltd.
*Stocks Carried.

ESTABLISHED 1915

THE OHIO GEAR COMPANY

1338 EAST 179TH STREET • CLEVELAND 10, OHIO

. . . ON YOUR PRODUCTION COSTS

If the machines or equipment you manufacture require gearing, speed reducers or motorized reducers, you can save substantially by standardizing on Ohio Stock Gears and Speed Reducers. They are precision made in every detail and fit perfectly into most applications. Produced in quantity runs they cost less and save the delivery time ordinarily required for "specials."

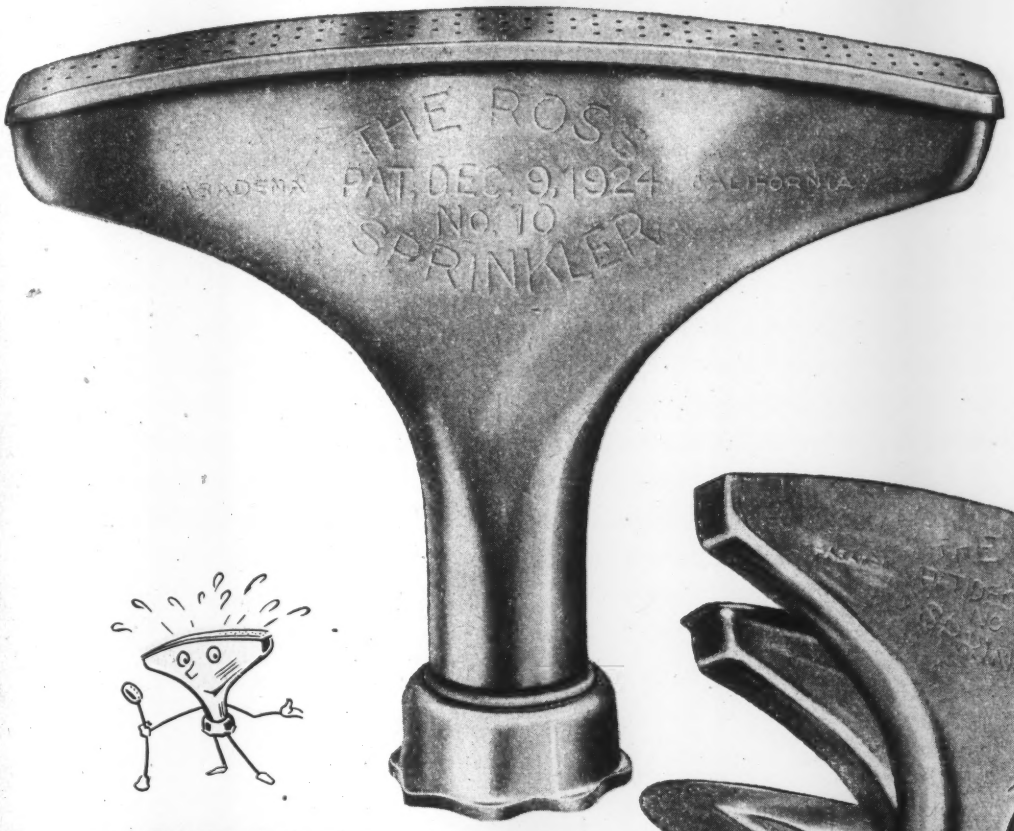
. . . ON YOUR MAINTENANCE COSTS

With Ohio Stock Gears and Reducers on your production machines you are sure of long, steady performance. However, when replacement becomes necessary, they cost less and you eliminate expensive down time waiting for deliveries.

*STANDARDIZE ON OHIO STOCK GEARS AND SPEED REDUCERS

Ohio Stock Gears and Speed Reducers are ordinarily available from your nearest distributors stock.

OHIO GEARS



ROSS SPRINKLER MAKES AN ANNOUNCEMENT:

"We say -- without hesitation -- that the brass Anaconda supplies for these sprinkler heads gives us the best drawing performance and the lowest reject rate of any brass we've ever used".

The Ross Sprinkler Company of Pasadena, California, in business since 1904, manufactures a broad line of Lawn Sprinkling Equipment and Air Conditioning Nozzles. Topmost illustration is full size; others indicate the extent of deep drawing required in producing the Ross No. 10 Solid Brass Hand Sprinkler.

This was no accident. The customer's equipment, together with the number and extent of draws, were carefully considered. Then a brass alloy of suitable composition and temper was supplied. Results were evident immediately.

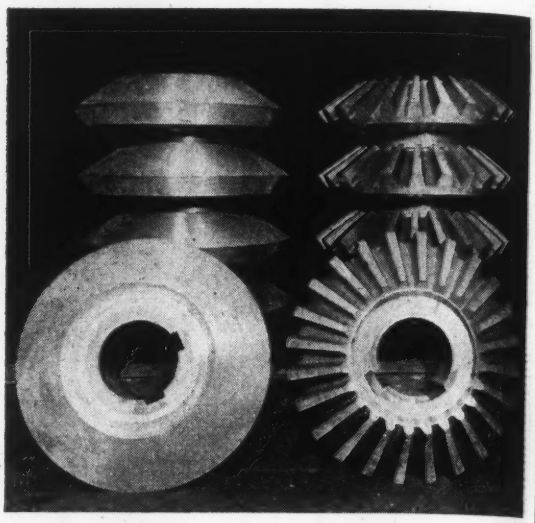
How about those deep-draw jobs of yours? Any room for improvement? Want the benefit of our experience — without obligation? . . . Just write to The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: New Toronto, Ontario. 50109

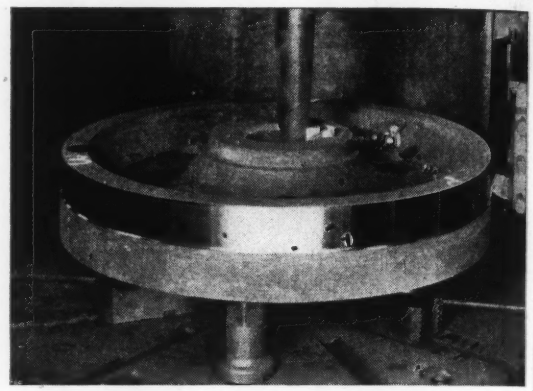
for better drawing brass

SPECIFY ANACONDA®

first in copper, brass and bronze

MAY WE SPEAK OUR PIECE ABOUT Gear Blanks?





These Bethlehem gear blanks are handsome to look at, and as good as they look. They're really something extra-special.

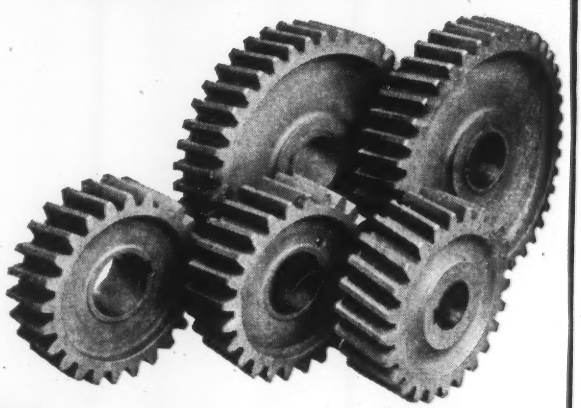
They're different from gear blanks made by conventional methods. In describing how they're made, we say that they're rolled and forged, or roll-forged. That is, the mill takes the hot blocks of steel, upsets them, and immediately rolls and forges in a single operation. Not just rolling, not just forging, but both . . . with the attendant *benefits* of both. Homogeneity, good grain structure, uniform density of metal.

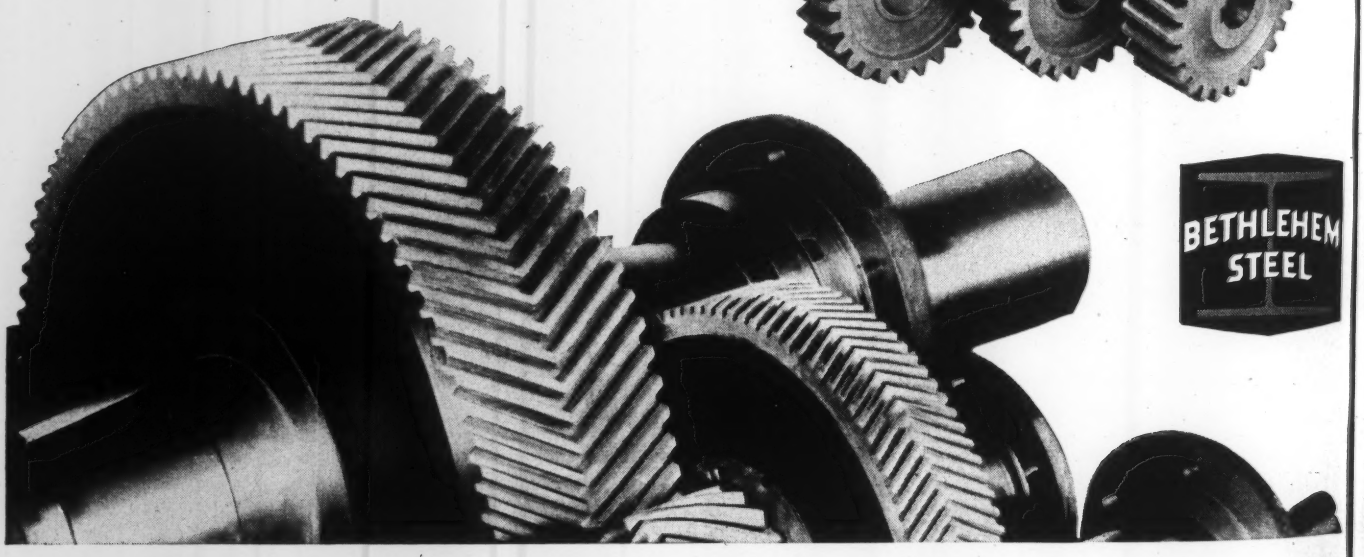
The blanks are also rough-machined (something you don't have to worry about yourself!); then they're shipped to you ready for finish-machining. Sizes, approximately 10 in. to 42 in. OD; orders heat-treated or untreated, as you specify.

You'll like these blanks—their strength, their fine surface, their all-around goodness. Be sure you get them when planning your next output of spur, herringbone, bevel, or miter gears. And write for Booklet 216—it tells about gear blanks and the many other uses of Bethlehem circular steel forgings.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation





BETHLEHEM ROLLED-AND-FORGED CIRCULAR PRODUCTS

MOTOR PARTS by R & M

For portable tools and *everything else* that needs compact, built-in power, Robbins & Myers Matched Motor Parts are adaptable—*always* dependable. They simplify modern styling; cut equipment assembly time. And, since R & M parts for all the different motor types are interchangeable, users get *utmost benefits* from product standardization.

PERFORMANCE TELLS THE STORY

As a *leading* motor-parts maker—with over forty years of service to the nation's volume users—Robbins & Myers has demonstrated time and again that broad experience, progressive ideas, and *willing cooperation* can meet exacting powering needs, whatever the requirements. In standardized elements, or parts built-to-order, the R & M concept and R & M skills save users time, trouble, and money.

INVESTIGATE THESE EXTRA VALUES

Millions of units for the plant, home, and office are "*Powered by Robbins & Myers*" because R & M Motors and Matched Motor Parts are so reliable and right. Find out what this can mean to you in satisfaction, savings. Sizes 1/200 to 50 h. p.

Robbins & Myers is big enough to serve your every need completely, yet not too big to serve you personally and promptly. For literature or gratis aid in solving powering problems, address Dept. E-120

MOTOR DIVISION

ROBBINS & MYERS INC.

SPRINGFIELD 99, OHIO
BRANTFORD, ONTARIO

MOTORS • HOISTS • CRANES • FANS • MOYNO PUMPS • FOUNDED 1878

DESIGN LEADERSHIP *Pays*

SQUARE D MACHINE TOOL RELAYS

Design Features

Small Size without sacrifice of accessibility or rating.

Accessible Terminals accommodate multiple connections.

Hardened Parts for long mechanical life. Magnet frame, armature, and other steel parts with bearing surfaces, are hardened.

Double-Break Silver Contacts, convertible from normally open to normally closed without additional parts, for maximum flexibility.

Two to Eight Poles in any combination of normally open and normally closed contacts.

Steel Panel Mounting and front connections.

Non-Carbon Tracking melamine yoke bar, together with porcelain contact block, for high arc resistance and dielectric strength.

Write **for Machine Tool Relay Bulletin 8502 BHO.**
Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin.

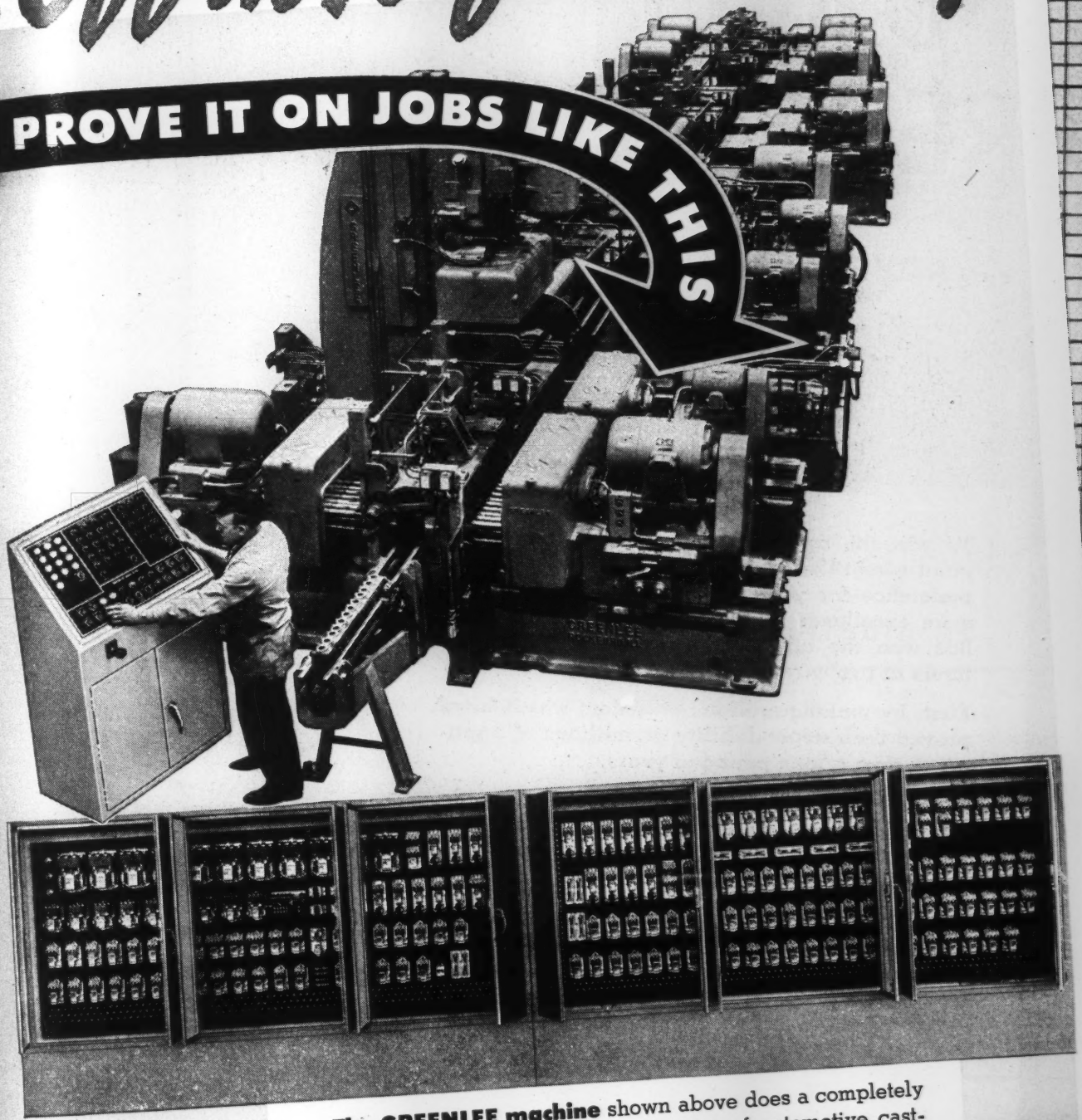
SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Off in Performance!

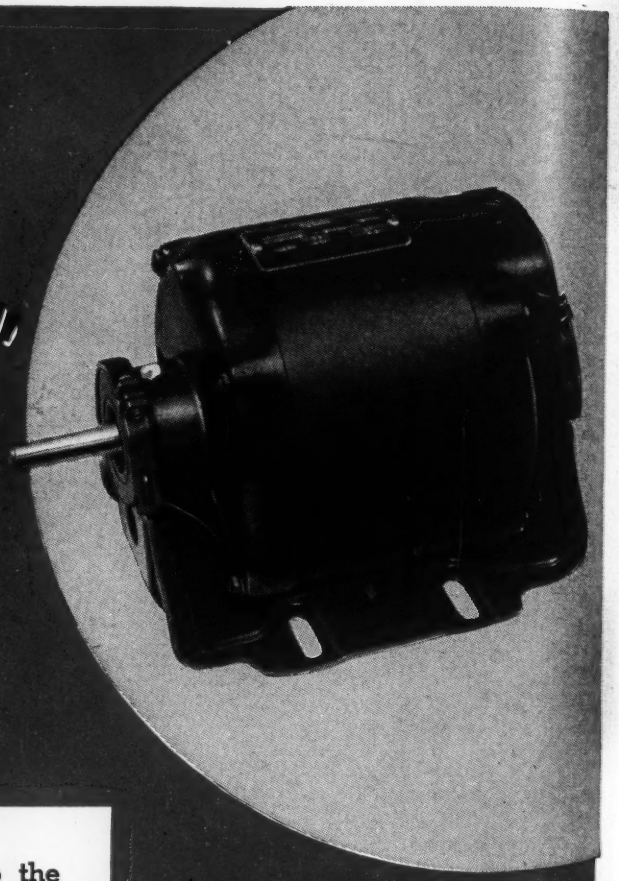
PROVE IT ON JOBS LIKE THIS



The GREENLEE machine shown above does a completely automatic job...straight line processing of automotive castings. "Down" time in mass production operations like this one can be a very costly factor. Square D's machine tool relays pay off because they're designed for consistent performance, long life, easy inspection and maintenance. They definitely minimize "down" time.

On spec sheets everywhere

"DELCO PREFERRED"



...pays tribute to Delco quality and flexible supply

To win the approval of manufacturers to the point where their specification sheets indicate a preference for your product implies more than mere excellence of design. Delco, for example, has won the approval of appliance manufacturers in two ways:

First, by making millions of motors which have proved their dependability on millions of appliances over a long period of years.

Second, by maintaining a flexibility of supply which functions even when unusual conditions in the market necessitate changes in specifications and deliveries.

The experience of others is often the best guide. Delco motors, designed to meet specific torque and service requirements, are available in sizes from 1/8 h.p. up.

For complete information on all types and sizes of Delco motors contact the nearest Delco office listed below.

DELCO DAYTON OHIO

DELCO MOTORS

DELCO PRODUCTS

Division of General Motors Corporation, Dayton, Ohio

THERE IS A DELCO MOTOR FOR:

Refrigerators
Washing machines
Dryers
Furnace blowers
Oil burners
Stokers
Water pumps
Gasoline pumps
Compressors
Home work shops
Fans (ventilating)
Dishwashers
Ironers
Office machines
Food grinders
Separators

SALES OFFICES: CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HARTFORD

Things you should know about BERYLLIUM COPPER to improve performance—to reduce cost.

From the many useful properties of beryllium copper, you can find the right combination to give your product competitive advantages through high performance and economy in production.

- **Readily formed or machined in the heat-treatable condition.**
- **Simple, low-temperature heat treatment for desired properties.**
- **Good electrical and thermal conductivity.**
- **High elastic and endurance strength.**
- **Non-magnetic.**
- **Minimum drift and hysteresis.**
- **Excellent resistance to corrosion and corrosion fatigue.**

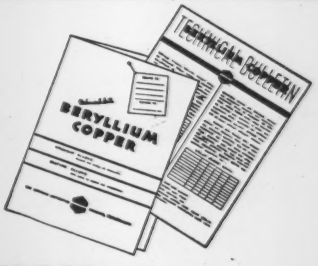
available as

ROD AND BAR
Rounds, Rectangles, Hexagons and others. Write for BULLETIN 13 for available forms and sizes.

WIRE
Heat-treatable and pretempered. Detailed information furnished on request.

STRIP
in Rolls or Lengths. Send for Bulletin 12 for full particulars.

HELPFUL ENGINEERING INFORMATION contained in a new series of Beryllium Copper Technical Bulletins. If you wish to receive these regularly, write us a note on your company letterhead.



BERYLLIUM

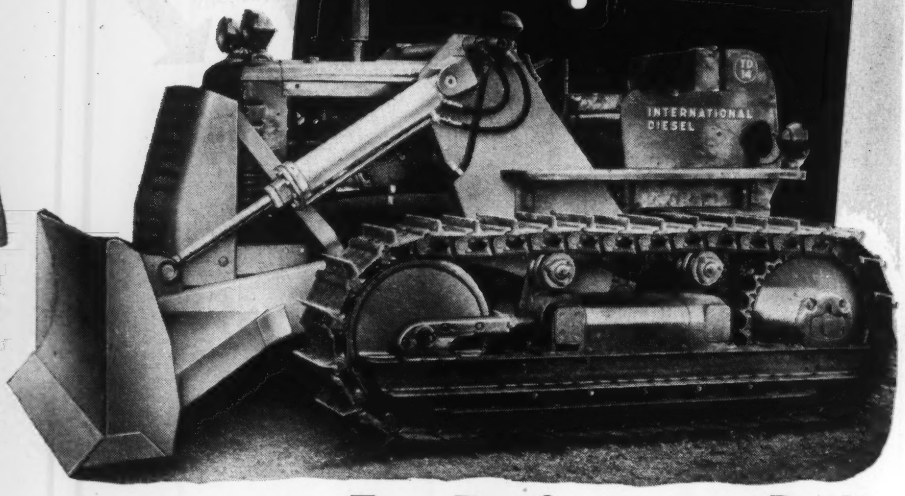
THE BERYLLIUM CORPORATION

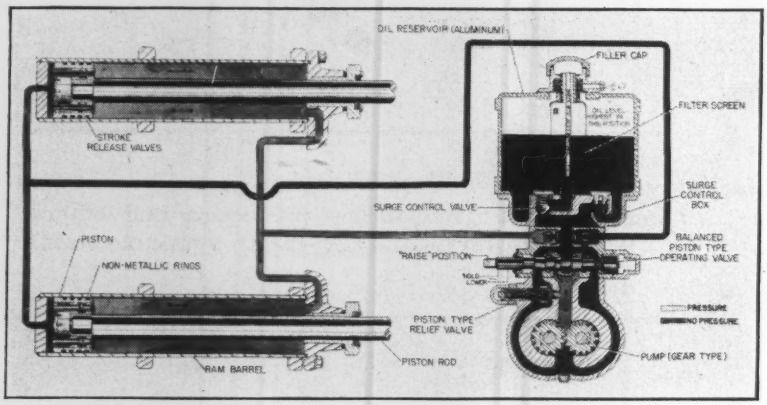
DEPT. 9, READING 1, PA.

Offices in New York, Springfield (Mass.), Cleveland, Dayton, Detroit, Chicago, Minneapolis, Seattle, San Francisco, Los Angeles • Representation in principal foreign countries

Good Equipment Made Still Better with LaPLANT-CHOATE HYDRAULIC UNITS

SPEED • POWER
VERSATILITY • SIMPLICITY
TROUBLE-FREE OPERATION





Top Performance Built into Bros Dozers with LPC Hydraulic Units

FOR their *Power-Plus* Bulldozer, Bros engineers wanted speed and power for fast work under heavy loads . . . instant response to controls . . . simple, compact design . . . trouble-free operation. A complete LaPlant-Choate Hydraulic System consisting of jacks and the famous "packaged" hydraulic fluid power unit, was chosen to meet all requirements . . . to make their *good* product still *better.*

Design Your Product for Better Performance

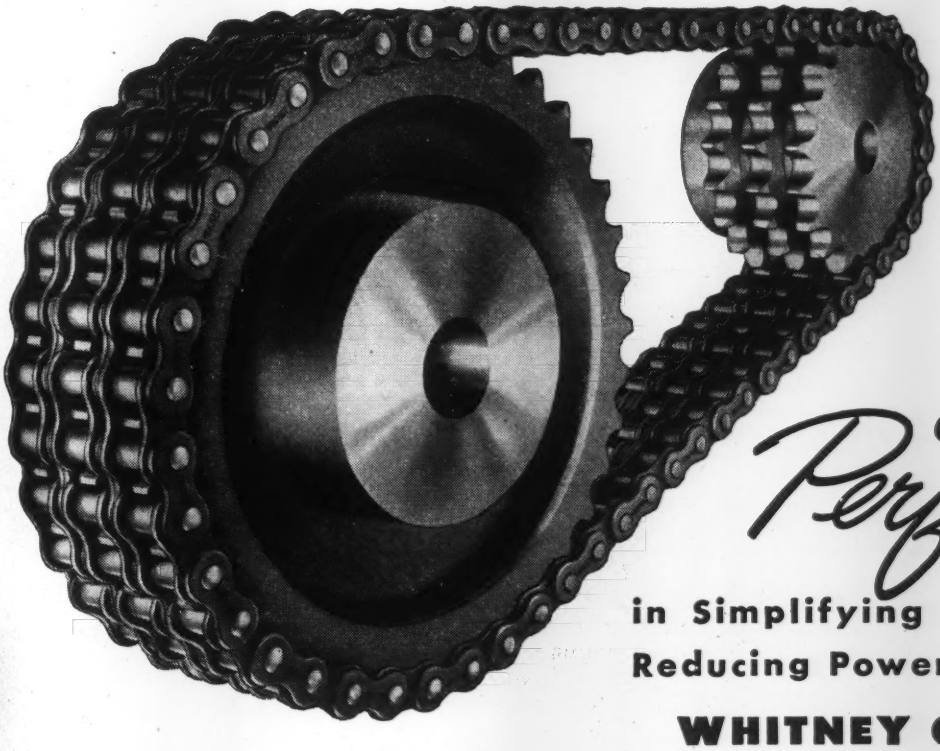
Whatever your problem, you'll get more efficient operation, simpler design and greater sales advantages for your product when you use LaPlant-Choate Hydraulic Units as standard equipment. Here are some of the features that will make your product better — *Compact Design* with pump, control valve, relief valve and reservoir contained in one simplified unit; *Versatile Application* on any type of machinery or equipment; *Multiple Use* of one installation with multiple valves, combinations and oil circuit variations; *Positive Fingertip Control* results in a high degree of operating accuracy and precision; *Easily Installed* and adaptable to a wide choice of mountings; *Low Maintenance* and *Long Life* under the most adverse operating conditions.

Write for complete information about making your products easier to design, manufacture, sell and service. Ask for Bulletin B-1152B LaPlant-Choate Manufacturing Co., Inc., Cedar Rapids, Iowa.

THE LaPLANT-CHOATE FAMOUS FLUID POWER CONTROL

Pump, valve and oil reservoir are all combined into a single compact unit that mounts on the front of the tractor behind the radiator guard. This new "closed system" design completely eliminates long suction lines, reduces the hazard of leaks and assures greatly increased speed and efficiency. In addition, the entire unit is skillfully engineered and precision built for utmost simplicity, easy servicing, and long, trouble-free operation.

LaPLANT CHOATE

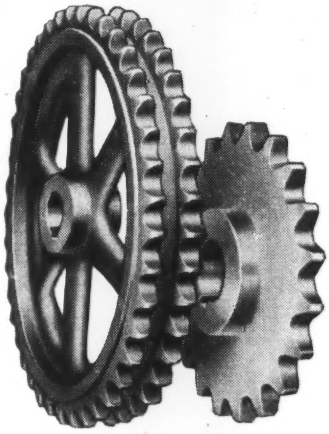


Star Performers

in Simplifying Drive Designs and Reducing Power Transmission Costs

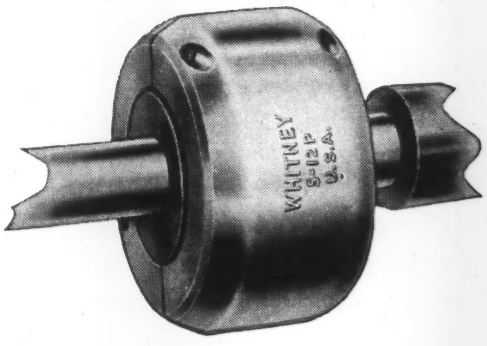
WHITNEY CHAIN DRIVES

Whitney Roller Chains in single or multiple widths.



Whitney Cut Tooth Sprockets for all types of chain.

Whitney Roller Chain Flexible Couplings for positive yet flexible direct drives.



Whitney Silent chains for quiet, high speed power transmission.

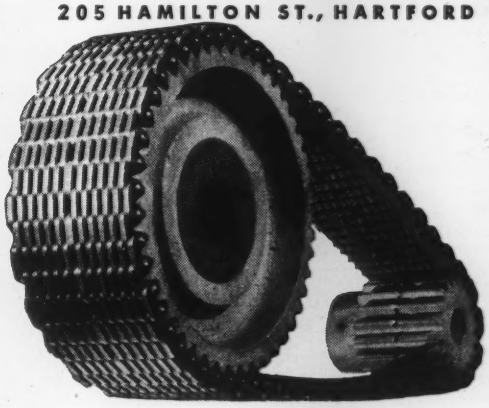
Cost and performance records across all types of industry . . . on all sorts of equipment . . . prove that versatile Whitney Chain Drives not only simplify your drive selection, but reduce costs as well.

For example — these quality drives will operate on long or short centers, drive shafts clockwise or counter clockwise . . . singly or simultaneously. And from the cost angle, remember that Whitney Chain Drives deliver *full rated* machine output without friction loss or slippage. Their alloy steel construction, to Whitneys' renowned quality standards, assure long service life with minimum maintenance.

PLUS WHITNEY SERVICE — And Remember — Whitney Chain Drives . . . roller, silent, conveying chains, and cut-tooth sprockets . . . are carried in stock by a nation-wide network of more than 130 Whitney distributors. This fast local service saves you time, assures prompt delivery of your chain drive requirements. In addition, 15 Whitney field offices, strategically located throughout the country, are at your service to help you solve your power transmission problems. For Catalog or specialized Whitney field offices write:

WHITNEY CHAIN COMPANY

205 HAMILTON ST., HARTFORD 2, CONNECTICUT



Wherever You are...

UNION CHAIN IS NEAR BY

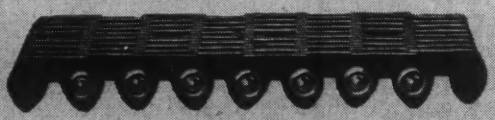
Suppose you need UNION Machine Finished Steel Roller Chain...

... and are certain of the pitch, length and sprockets required. Just write or phone your nearest Union Chain Stock Carrying Distributor as listed on the facing page. More likely than not, your requirements will be shipped immediately.

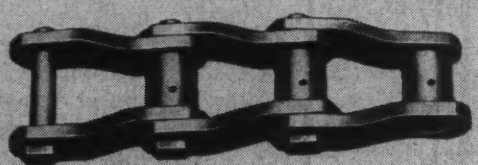
... or suppose you need engineering assistance in the selection of a drive or a recommendation for a conveyor application. Talk or write to Union Chain's nearest district office as listed at the top of the facing page. You will receive unprejudiced, competent help.

Unprejudiced because Union Chain makes all types of steel sprocket chains and is interested in providing each customer with the correct chain for satisfactory service at minimum cost.

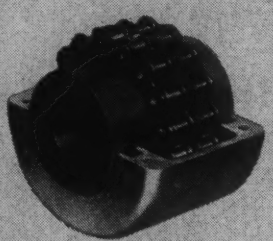
Competent because Union Chain representatives are qualified through experience to make sound chain recommendations whether the application calls for roller chain, silent chain or one of the various heavy drive or conveying chains. We suggest it might profit you to discuss your chain problems with us.



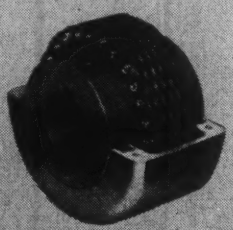
UNION SILENT CHAIN



UNION HEAVY DRIVE AND CONVEYING CHAINS



UNION ROLLER CHAIN FLEXIBLE COUPLINGS



UNION SILENT CHAIN FLEXIBLE COUPLINGS

UNION CHAIN REPRESENTATIVES

CALIFORNIA
American Chain & Gear Co.
C. A. Nicholas
5511 Pacific Blvd.
Huntington Park, Calif.

GEORGIA
H. F. Edge
208 Walton Bldg.
Atlanta, Georgia

ILLINOIS
Union Chain & Mfg. Co.
W. Albrecht
A. C. Mohr
B. Nelson
Room 1232
53 W. Jackson Blvd.
Chicago, Illinois

INDIANA
Paul W. Huddlestun
5745 Guilford Ave.
Indianapolis 20, Indiana

LOUISIANA
F. N. Johnston Co.
2207 American Bank Bldg.
New Orleans, La.

MASSACHUSETTS
Transmission Engineering Co.
Stanley Johnson
6 Hartford St.
Newton Highlands 61, Mass.

MICHIGAN
Union Chain & Mfg. Co.
W. J. White
Basso Bldg.
7338 Woodward Ave.
Detroit 2, Michigan

MINNESOTA
F. H. Bathke
490 N. Snelling Ave.
St. Paul, Minn.

MISSOURI
J. B. Flaherty
5473 Delmar Blvd., Rm 206
St. Louis, Missouri
Ed Schiefelbein
311 West 10th St.
Kansas City 6, Mo.

NEW YORK
John B. Foley
107 Tully St.
Syracuse, New York
Mays & Gleason, Inc.
50 Church St.
New York 7, New York
Potter & Dugan, Inc.
29 Wilkeson St.
Buffalo, New York

NORTH CAROLINA
M. R. Snyder Co.
304 E. Tremont Ave.
P. O. Box 3341
Charlotte 3, N. Carolina

OHIO
Fred W. Borrow
3330 Montgomery Rd.
Cincinnati 7, Ohio
Union Chain & Mfg. Co.
F. H. Dalrymple
F. Smiley
Marshall Bldg.
Cleveland 13, Ohio

OREGON
J. W. Minder Chain & Gear Co.
307 S. E. Hawthorne Blvd.
Portland 14, Oregon

PENNSYLVANIA
David Davies
P. O. Box 4
Plymouth, Pa.
F. R. Magill Company
44 McKnight St.
Pittsburgh 20, Pa.
Union Chain & Mfg. Co.
John A. Shoemaker
Room 521
Schaff Bldg.
Philadelphia 2, Pa.

TEXAS
Union Chain & Mfg. Co.
J. H. Castleberry

918 Magnolia Bldg.
Dallas, Texas

VIRGINIA
C. Arthur Weaver Co.
403 E. Franklin St.
Richmond 19, Virginia

WISCONSIN
Union Chain & Mfg. Co.
George H. Harris
Room 508
Wisconsin Tower Bldg.
606 W. Wisconsin Ave.
Milwaukee 3, Wisconsin

SPECIAL Representatives

NEW YORK
Frank L. Allen
82 Wall St.
New York 5, New York
E. F. Gahan
500 Fifth Ave.
New York, New York

OREGON
W. D. Hollingworth
307 S. E. Hawthorne
Portland, Oregon

FOREIGN Representatives

ARGENTINA
Stevens & Villasuso
Munecas 110
Tucuman, Argentina

BRAZIL
W. G. Winslow
Rua Xavier de Toledo
No. 70 5° Andar
Caixa Postal 6064
Sao Paulo, Brazil

CUBA
Central Machine & Trading Co., S.A.
Lamparilla 208
Havana, Cuba

HAWAII
P. S. Pell & Co.
88 S. Queen Street
Honolulu, T. Hawaii

MEXICO
Thomas M. Nevin Y. Cia. S.A.
Manuel Maria Contreras 58
Mexico, D. F., Mexico

PHILIPPINES
The Edward J. Nell Co.
1450 Arlegui St.
Manila, Philippines

PUERTO RICO
Manual, Pales, Jr.
P. O. Box 2969
San Juan 13, Puerto Rico

SOUTH AFRICA
Robins Conveyors (South Africa) Ltd.
Samkay House.
Cor. Troye & Marshall Sts.
P. O. Box 4736
Johannesburg, S. Africa

UNION CHAIN STOCK CARRYING DISTRIBUTORS

ALABAMA
Mill & Mine Supply Company
124 S. 20th Street
Birmingham, Alabama

ARKANSAS
Service Supply Company, Inc.
20 North University Street
P.O. Box 145, University Station
Fayetteville, Arkansas

CALIFORNIA
Valley Belting & Equipment Co.
2309 Los Angeles St.
Fresno, Calif.

CONNECTICUT
Motor Equipment Co.
Wall & Water Sts.
Bridgeport 3, Connecticut
Transmission Equipment Co. of Connecticut
250 Boulevard
New Haven 11, Connecticut

DELAWARE
L. W. Rapkin Co.
Third St. & Shipley
Wilmington 40, Delaware

FLORIDA
Ellis & Lowe Co., Inc.
302-306 S. Morgan St.
Tampa, Florida
Farquhar Machy. Co.
720 West Bay St.
Jacksonville, Florida
General Equipment & Supply Co.
552 N. W. 5th Street
P.O. Box 1470
Miami, Florida

GEORGIA
Bearings & Drives, Inc.
515 Arch Street
Macon, Georgia
Georgia Hardware & Supply Co.
307 N. Washington St.
Albany, Georgia
Macon Supply Co.
Macon, Georgia
Richmond Supply Co.
Augusta, Georgia
John D. Robinson Co.
13 Bay Street, West
Savannah, Georgia
J. M. Tull Metal & Supply Co.
285 Marietta St. N. W.
Atlanta 3, Georgia

ILLINOIS
Hagerty Bros. Co.
923 S. Washington St.
Peoria 2, Illinois

ILLINOIS
W. M. Hales Co.
Hillsboro, Illinois
W. M. Hales Co.
W. Frankfort, Illinois
Mid-States Industrial Corp.
2401 Eleventh St.
Rockford, Illinois
Northern Illinois Supply Co.
Carpentersville, Illinois

INDIANA
Diamond Supply Co., Inc.
616-24 N. W. Second St.
Evansville, Indiana
Service Equipment Center, Inc.
Indianapolis, Indiana
The South Bend Supply Co.
South Bend, Indiana

KANSAS
Bearing Service Co.
341 N. St. Francis Ave.
Wichita 2, Kansas
W. A. Thomas Supply Co.
112-114 West Third St.
Pittsburg, Kansas

KENTUCKY
Sherman Bros. Mill Supply
222 South Shelby St.
Louisville 2, Kentucky

LOUISIANA
Dixie Bearing & Supply Co., Inc.
733 N. 21st St.
Baton Rouge, La.
Weaks Supply Co., Ltd.
Monroe, Louisiana
Woodward Wight & Co., Ltd.
New Orleans, La.

MARYLAND
Hagerstown Equipment Co.
Maryland Ave. & Memorial Blvd.
Hagerstown, Md.
M. F. Holland Co.
Lee & Sharp Sts.
Baltimore, Md.

MINNESOTA
Jurgens Company
519 Cleveland Ave.
St. Paul 4, Minnesota

MISSOURI
Industrial Equipment Corp.
325 E. Walnut St.
Springfield, Missouri
Teuscher Pulley & Belting Co.
801-805 N. Second St.
St. Louis, Missouri
Wildhagen Machine & Supply Co.
224 S. Third St.
St. Joseph 5, Missouri

NEW JERSEY
Burton Supply Co.
390 Union Ave.
Paterson, New Jersey
Mill Supply & Hardware Co.
285-289 N. Willow St.
Trenton 4, New Jersey
Old Reliable Supply & Equipment Co.
11th St. & Newton Ave.
Camden, New Jersey

NEW MEXICO
Union Industrial Corporation
112 East Mermod St.
Carlsbad, New Mexico

NEW YORK
Laurence Belting Co.
111 Chambers St.
New York, New York
S. H. Pooley Belting Co.
38 W. Seneca Street
Buffalo 2, New York
Transmatic Equipment Co.
11 North Pearl St.
Albany, New York
U. & S. Inc.
Lincoln Bank Bldg.
509 S. W. Street
Syracuse, New York
Ulster Foundry Corp.
20 St. James St.
Kingston, New York

NORTH CAROLINA
Piedmont Mill Supply Co.
P. O. Box 130
Salisbury, N. Carolina

OHIO
Brubaker Gear & Mfg. Co.
Barberton, Ohio
Cincinnati Transmission Co.
3330 Montgomery Road
Cincinnati 7, Ohio
C. J. Edwards Company
5005 Euclid Avenue
Cleveland 3, Ohio
Lima Armature Works, Inc.
440 N. Main St.
Lima, Ohio
Mill & Factory Supply Co.
317–10th St.
Toledo, Ohio
Wilkof Hardware & Supply Company
1100 Warner Road, S. E.
Canton, Ohio
Winkle Electric Co., Inc.
701 Andrews Avenue
Youngstown 2, Ohio

OKLAHOMA
C. F. Dagwell & Company
816 W. Main St.
Oklahoma City, Okla.
Ore Reclamation Company
301 N. Connell Ave.
Pitcher, Oklahoma

OREGON
Electric Steel Foundry
Eugene, Oregon
Fisher Bros. Company
522 Bond Street
Astoria, Oregon
Industrial Machinery & Supply Co.
1410 Adams Avenue
La Grande, Oregon
Industrial Steel & Supply Co.
North Bend, Oregon

PENNSYLVANIA
A. C. Supply Company
1330 Federal Street
Philadelphia, Pa.
Ace Bearing Company
246 Hamilton St.
Allentown, Pa.
Ace Bearing Company
P. O. Box 183
1120 Wyoming Avenue
Scranton 1, Pa.
S. S. Brenner
2303 E. Philadelphia Street
York, Pa.
Industrial Supply Co.
451 E. Broad St.
Hazleton, Pa.
Maximon Machine Co.
801 N. Logan Blvd.
Altoona, Pa.
Reilly Bros. & Raub
44 N. Queen St.
Lancaster, Pa.
Transmission Equipment Co.
903 E. Carson St.
Pittsburgh 10, Pa.

SOUTH CAROLINA
Southern Mill Supply Co.
Summerville, S. Carolina
Thackston-Davis Supply Co.
828 Gervais Street
Columbia, South Carolina

TENNESSEE
Hoyt N. Payne Co.
P. O. Box 942
410 E. Depot Ave.
Knoxville, Tenn.
Tennessee Machinery Co.
114-119 Third Ave., South
Nashville 3, Tenn.

TENNESSEE
Tipps Engineering & Supply Co., Inc.
260 N. Front St.
Memphis, Tenn.

TEXAS
Allied Belting & Trans. Co.
2614 Sylvan Ave.
Dallas, Texas
Beacon Supply Co., Inc.
1825 Washington Ave.
Houston 10, Texas
El Paso Machine Works, Inc.
1600 E. 4th St.
El Paso, Texas
Great Western Supply Co.
14th & Throckmorton
Fort Worth, Texas
J. & J. Armature Works, Inc.
1136 Neches St.
Beaumont, Texas
Lloyd Electric Co.
511 El Paso St.
San Antonio, Texas
Overton & Mims, Inc.
2703 Main St.
Dallas, Texas

VIRGINIA
Blue Ridge Hardware & Supply Co.
Bassett, Virginia
Mill Supplies Corp.
South Norfolk, Va.

WASHINGTON
Electric Steel Foundry
1327 Washington St.
Spokane, Washington

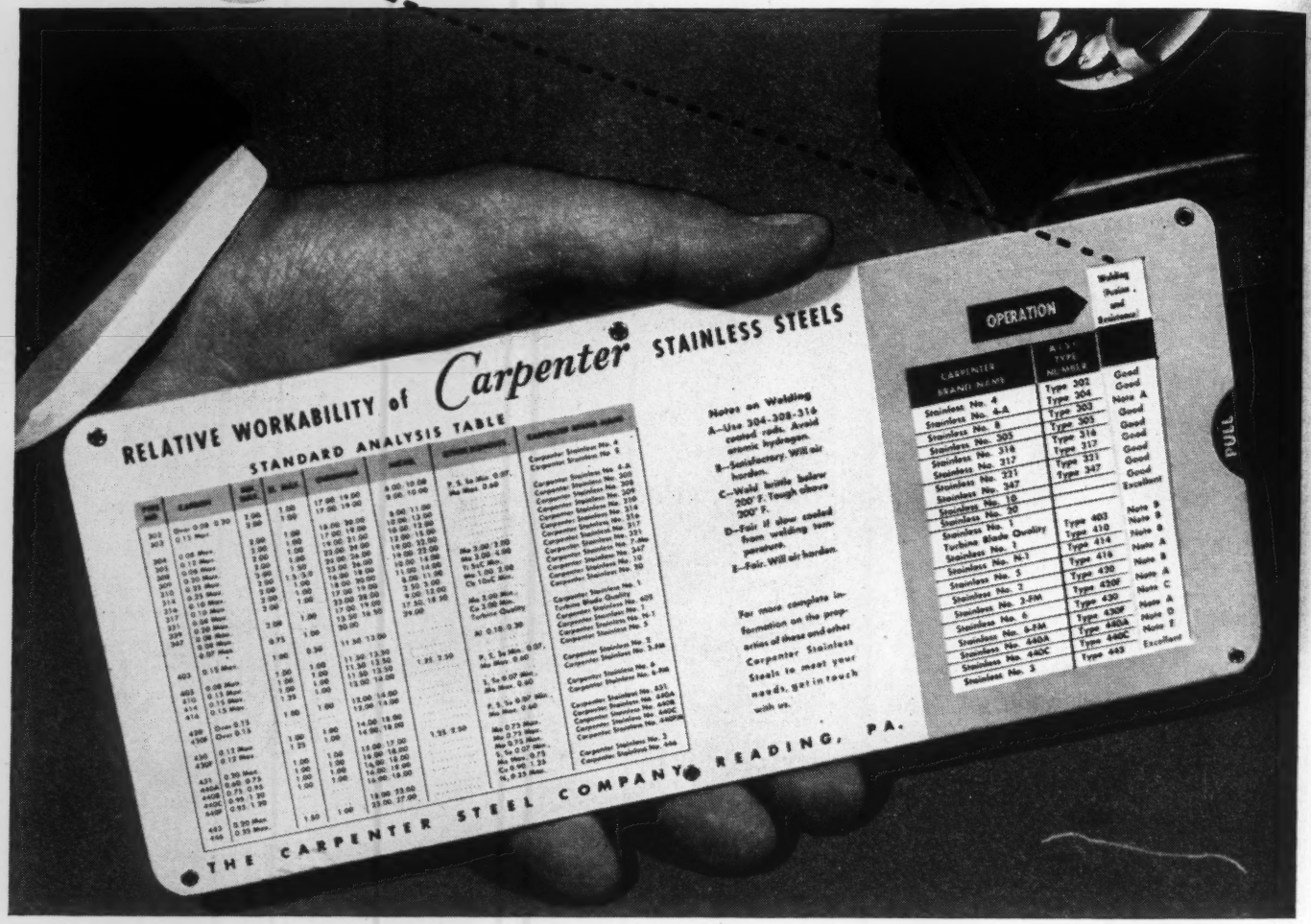
WEST VIRGINIA
Smith Steel Supply Co.
150 Peninsula St.
Wheeling, W. Va.

WISCONSIN
Dale Industrial Supply Co.
528 Forest St.
P. O. Box 867
Wausau, Wisconsin
Richard E. Ela Co.
744 Williamson St.
Madison, Wisconsin
F. D. Haker Co.
713 South Tenth Street
Milwaukee 4, Wisconsin
Spence Corporation
2045 West St. Paul Ave.
Milwaukee, Wisconsin

The Union Chain and Manufacturing Company **Sandusky, Ohio, U.S.A.**

TRANSMIT POWER
UNION CHAINS
CONVEY MATERIALS

MARKS THE SPOT



Where *Carpenter* Helps You in Your Work with Stainless

Getting better machined finishes, longer tool life and fewer rejects on Stainless jobs is the answer to—

- **increased production from every shift**
- **more parts from every pound of material**

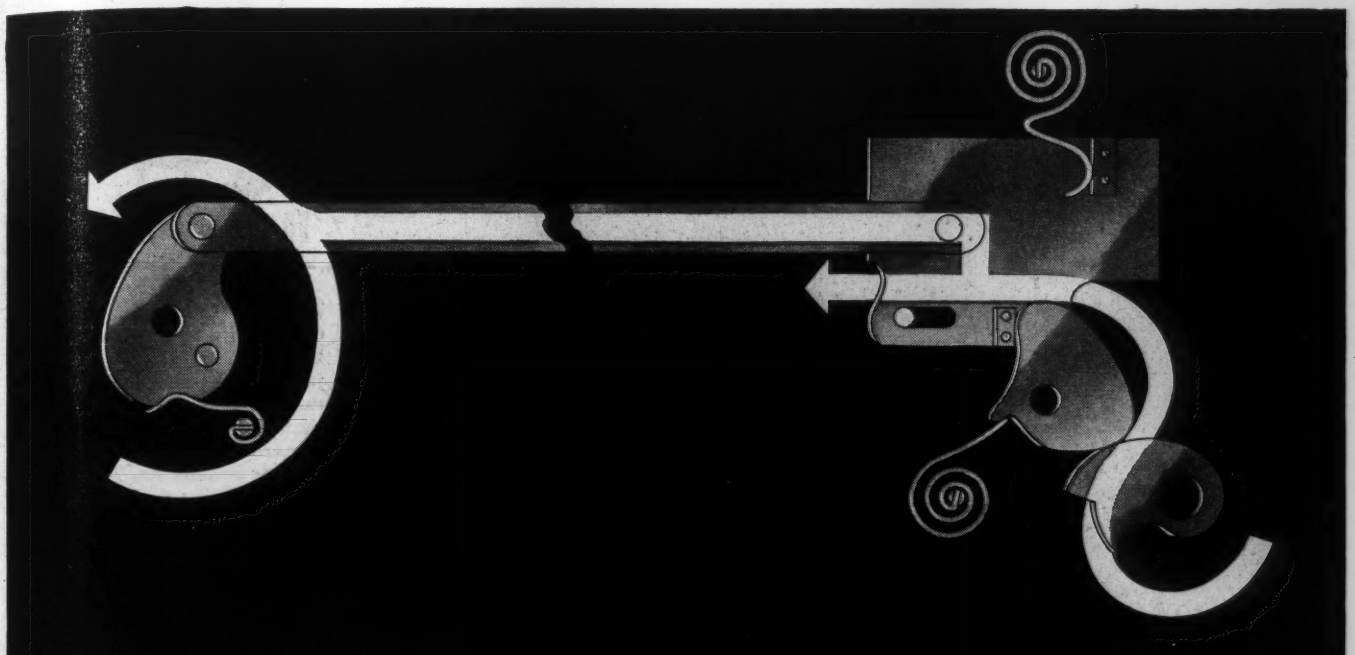
To make Stainless Steel do its best for you, take advantage of the help Carpenter can provide. We'll be glad to give you personal help in the shop and useful printed information that makes it easier to work with Stainless.

The new Carpenter Stainless Slide Chart quickly gives you information your men need to know. It gives the relative workability for many grades, useful information for jobs where you do *blanking*, *deep drawing*, *forging*, *heading*, *machining*, *welding*, etc. You will also find a complete table of information on the physicals for the Stainless grades. Just drop us a note, on your company letterhead indicating your title, and we will put your Carpenter Stainless Slide Chart in the mail for you.

The Carpenter Steel Company, 120 W. Bern St., Reading, Pa.
Export Department: Woolworth Bldg., New York 7, N.Y.—"CARSTEELCO"

Carpenter
more than corrosion resistance
STAINLESS STEEL
takes the problems out of production

For Easy-to-Use Stainless Call Carpenter! Warehouses in principal cities throughout the country.



If it needs to behave like a latch, a lock, or a linkage...

we can create it... mass produce it... precisely

...WITH STAMPINGS!

What's to be gained with a well-designed mechanical motion?

Often, better performance. Often, greater safety. Often, more operating convenience. A properly designed motion can frequently improve *all* of these and therefore, your product's sales appeal.

How do you put such things into a motion? Should it operate by a spring, a cam, a lever, or a pedal? Does it latch, lock, catch, or trip? Must it slide, swing or rotate? Will it be subjected to excessive vibration? Must it be concealed? Our engineering staff has answered these questions for a number of customers, and designed devices to meet their particular set of conditions.

When it comes to manufacturing, we mass produce such devices by *stamping* to keep the cost very low. Out of our experience, we have developed a variety of quality control techniques for holding assembly to unusually close tolerances.

If this design experience and our careful manufacturing approach suggest new product possibilities to you, they can be put to work on your problem. Our engineers would be happy to discuss it with you.

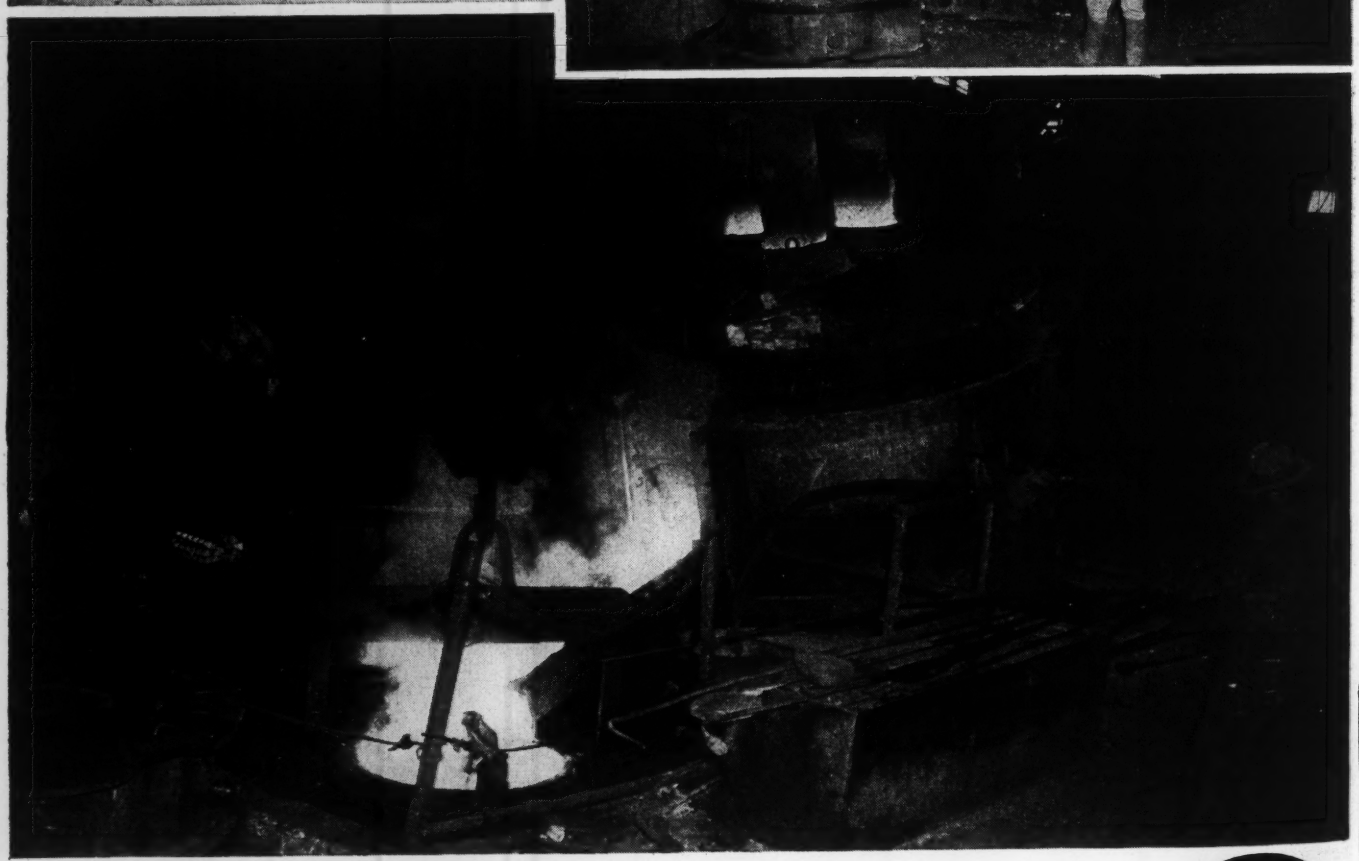
Our new booklet, "We Make Motions", explains our facilities further. Why not write for your copy today?

THE REID DIVISION OF *The Standard Products Co.*

THE MARK OF A SUPERIOR PRODUCT

DEPT. C, GENERAL OFFICES: 2130 WEST 110 STREET • CLEVELAND 2, OHIO

WE MAKE MOTIONS



Symbol of Highest Quality

To users of industrial gears and castings NE offers complete control from raw materials to finished product—modern foundry facilities both open hearth and electric, permit prompt attention to your requirements. Consult with us. Ask for bulletin No. 7.

NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

PUROLATOR ENGINEERS

Choose PERMITE

ALUMINUM CASTINGS

The body for a good oil filter should be seamless, light-weight, non-corrosive, attractive in appearance — and contribute to manufacturing economy. How these requirements were met by Permite Aluminum Castings (produced by the permanent mold process) for the Purolator Oil Filter shown here, is told by Purolator Products, Inc., Rahway, N. J., a leading manufacturer of oil filters for the automotive industry.

Letter from Purolator says:

"Here are a few reasons why our design engineers prefer Permite castings:

1. **The material can be cast in one piece, which makes for accuracy and low cost.**
2. **Machinability of Permite is excellent.**
3. **Permite aluminum castings do not need special finishing because they have their own bright, colorful, shiny finish.**
4. **Aluminum is non-corrosive, does not oxidize, therefore does not need protection.**
5. **A Permite aluminum casting is light in weight, yet has excellent strength factors and can easily withstand the stress placed upon it, in its use, attached to the engine of an automobile."**

This Purolator Oil Filter — with Permite cast aluminum body — is a special full flow type used as original equipment on one of America's finest automobiles.

Have *you* thought about using Permite castings in your products? It's possible that light-weight, precision-made Permite Aluminum Castings could save you thousands of dollars a year in handling costs, machining costs, finishing costs, shipping costs. Send us your blueprints and castings requirements for free quotations and recommendations.

ALUMINUM INDUSTRIES, INC.

CINCINNATI 25, OHIO

DETROIT, 809 New Center Building · NEW YORK, 7 Rockefeller Plaza · CHICAGO, 35 E. Jackson Boulevard · ATLANTA, 413 Grant Building

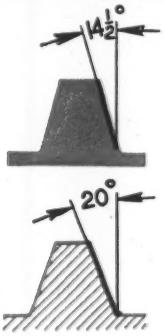
ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS . . HARDENED, GROUND and FORGED STEEL PARTS

Important Notice to all readers of Machine Design

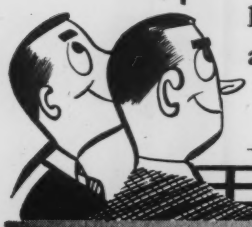
BOSTON GEARS cut 20° Pressure Angle

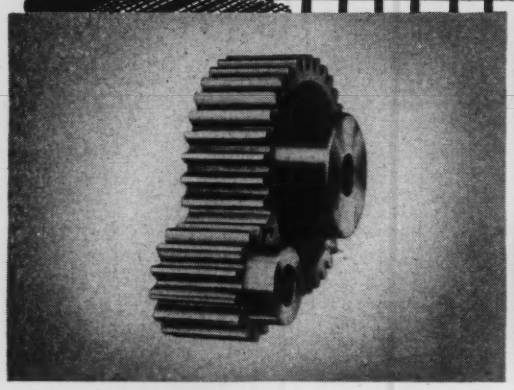
Quieter — Longer Life

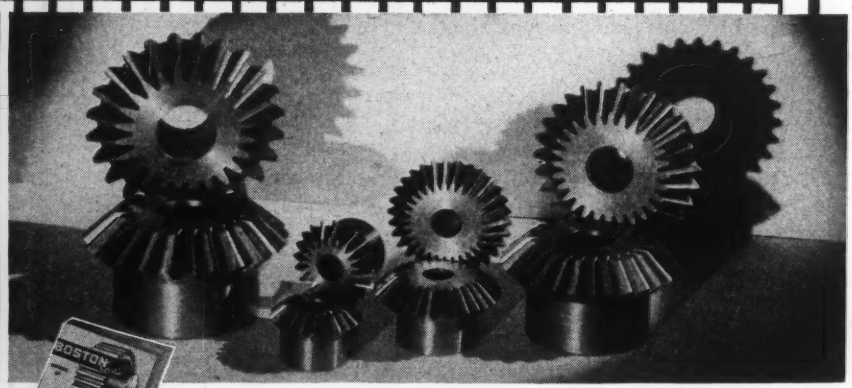
- **TRANSMIT MORE HORSEPOWER**
- **RUN QUIETER** • **LAST LONGER**



ASK THE NEAREST BOSTON GEAR DISTRIBUTOR to show you a pair of Boston Gears cut *20° Pressure Angle.* See for yourself why they are stronger and will take loads otherwise requiring heavier pitch, larger pitch diameter, more expensive, 14½° angle gears. Design them into your equipment.







BOSTON SPUR GEARS cut 20° Pressure Angle are *stocked* in 12 – 10 – 8 – 6 and 5 pitch sizes. Consult your new Boston Gear Catalog No. 55.

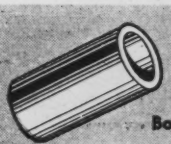
FOR COMPLETE INFORMATION on Boston Gears write for free copy of Boston Gear Catalog No. 55.

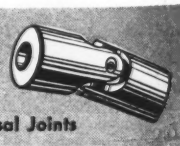
ALL BOSTON STEEL MITER GEARS are made with a 20° Pressure Angle and with flat (not "cupped") gear end surface for quick, compact, precise assembly and quick, sure alignment when installed. Available from nearby stock. See Catalog No. 55.

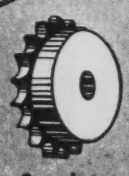
BOSTON *gear* stocks are *Near*

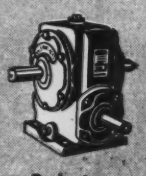
BOSTON GEAR WORKS

64 HAYWARD ST., QUINCY 71, MASS.

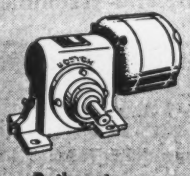

Bost-Bronz Bearings

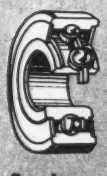

Universal Joints

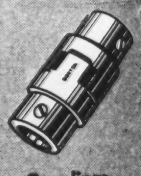

Sprockets


Reductors

Pillow Blocks


Ratiomotors


Bearings


Couplings

Take a tip from the people who run Railroads

YOU can date a renaissance in railroad equipment from the time when the first stainless steel streamliners appeared in the 1930's. In stainless steel, railroad management found a material that introduced a whole new set of values . . . so strong that it permits lightweight construction which saves large amounts in fuel costs . . . so corrosion-resistant and everlasting that cleaning, maintenance and depreciation costs are cut to the bone.

The public is benefitted with faster, safer, more comfortable and modern travel accommodations; the roads benefit because stainless steel saves on expenses and increases profits. Today you'll find Allegheny Metal used not only for entire trains, but in dining-car kitchens, sleeping-car equipment, refrigerator cars, and tank cars for the transportation of milk, chemicals, etc.

Rail equipment is only one of the vital uses for stainless steel in general industry and the national defense. In the past decade, we have spent many millions to increase the supply of Allegheny Metal and other alloy products, and are in the process of spending millions more. ● In the national interest, let us help you to use stainless steel most efficiently, and make the available supply go farther.

* * * * *

Complete technical and fabricating data—engineering help, too—are yours for the asking from Allegheny Ludlum Steel Corporation, Pittsburgh, Pa. . . . the nation's leading producer of stainless steel in all forms. Branch Offices are located in principal cities, coast to coast, and Warehouse Stocks of Allegheny Stainless Steel are carried by all Joseph T. Ryerson & Son, Inc. plants.

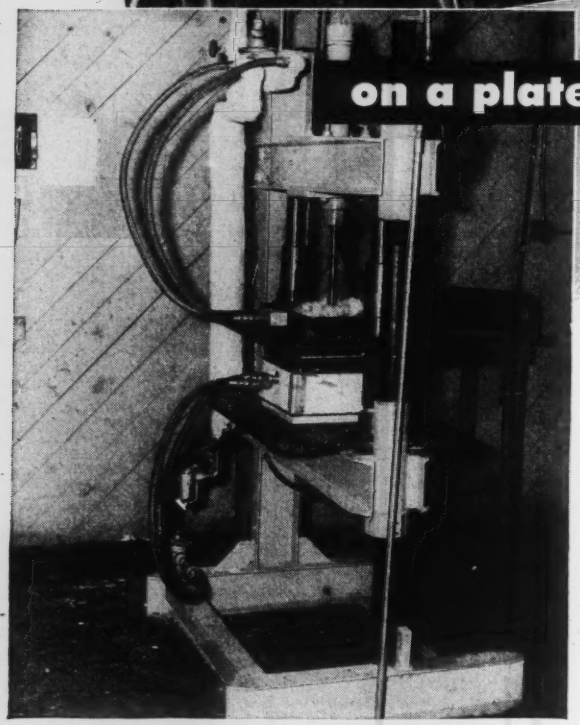
W&D 3149

You can make it **BETTER** with

Allegheny Metal

AL
TIME-TESTED STAINLESS STEEL

Where Connections Must Move . . .



CMH

FLEXIBLE METAL HOSE solves the problem economically and dependably

Whatever the product you are designing—if connections must be made between relatively movable parts to convey high or low temperature liquids or gases under pressure or vacuum, CMH Flexible Metal Hose is the answer. CMH corrugated flexible metal hose will withstand frequent and repeated flexing . . . has high resistance to external damage. REX-WELD steel and bronze hose is available in standard sizes from 3/16" through 12" I.D. for burst pressures to 12,000 psi, temperatures to 1000° F. REX-FLEX stainless steel hose is manufactured in sizes from 5/16" through 6" I.D. for working pressures to 2000 psi, temperatures to 1400° F. Both types are available with or without metal braid covering.

Literature and data sheets are available for CMH REX-WELD and REX-FLEX corrugated flexible metal hose. Write, today, briefly outlining the nature of your flexible connection problem and we will be pleased to send you the appropriate descriptive material.

Flexon identifies CMH products that have served industry for over 48 years.

CHICAGO METAL HOSE Corporation

1339 S. Third Avenue • Maywood, Illinois • Plants at Maywood, Elgin and Rock Falls, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems
Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

MEMO

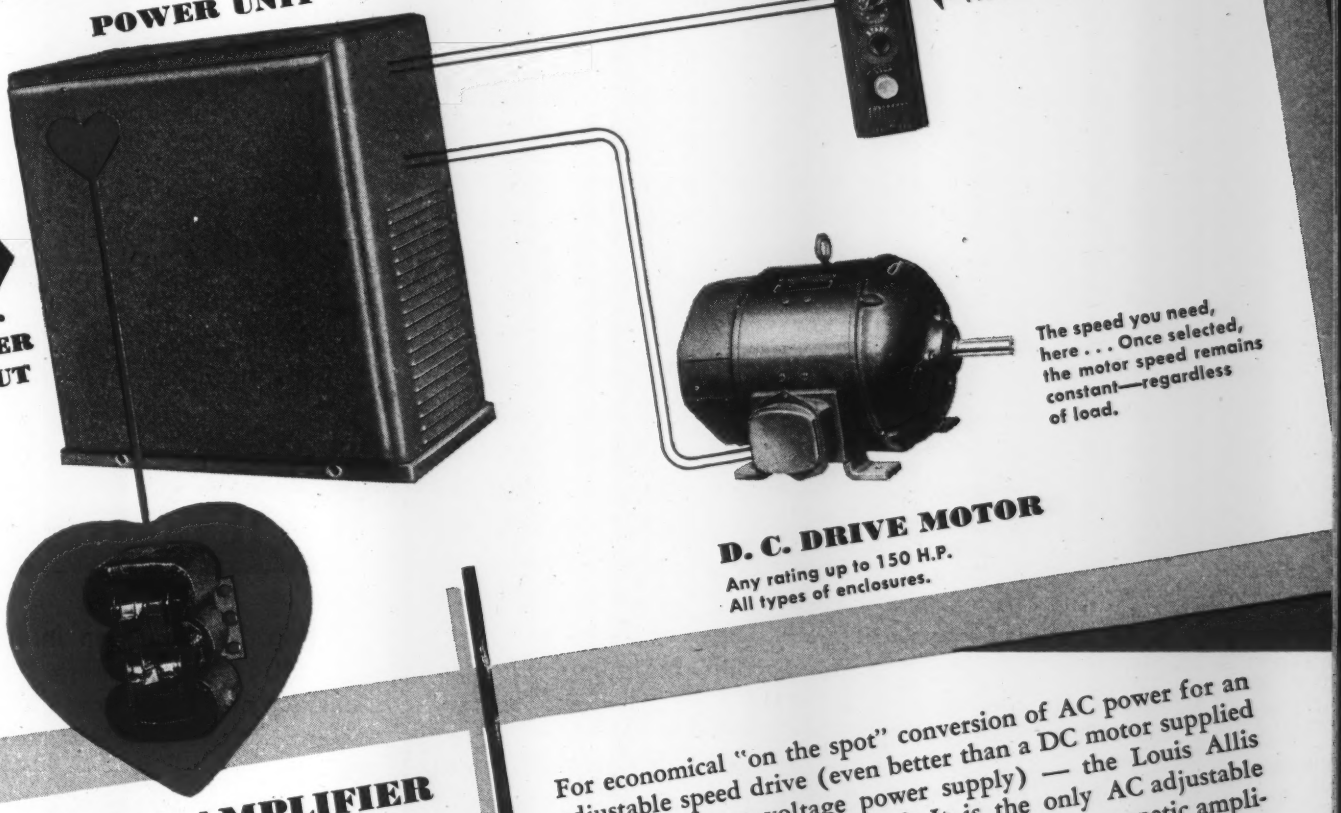
To: users of A.C. adjustable Speed Drives

from: THE LOUIS ALLIS CO.

Only SELECT-A-SPEDE

offers the NEW MAGNETIC AMPLIFIER CONTROL with superior performance at no extra cost!

Easy to install and operate • Simple circuits, easy to maintain • Compact design saves floor space



THE MAGNETIC AMPLIFIER

– HEART OF THE SELECT-A-SPEDE

The Magnetic Amplifier, a self-saturating reactor, like a transformer, contains no moving parts — no parts requiring maintenance or periodic replacement. Its function in the Select-A-Spede, is to constantly regulate the field currents of both motor and generator. It requires no "warm up" period, has an extremely fast response to changing conditions, and is completely reliable at all times.

For economical "on the spot" conversion of AC power for an adjustable speed drive (even better than a DC motor supplied from a constant voltage power supply) — the Louis Allis Select-A-Spede is unsurpassed. It is the only AC adjustable speed drive offering the advantage of the new magnetic amplifier control — with close speed regulation at all rated speeds and loads.

The Select-A-Spede also offers a variety of optional features, such as: reversing, dynamic braking, jogging, sequence control, controlled acceleration, interlocked slow speed start, multi-motor drives, etc. It is possible to provide a Select-A-Spede Drive to exactly suit your special requirements.

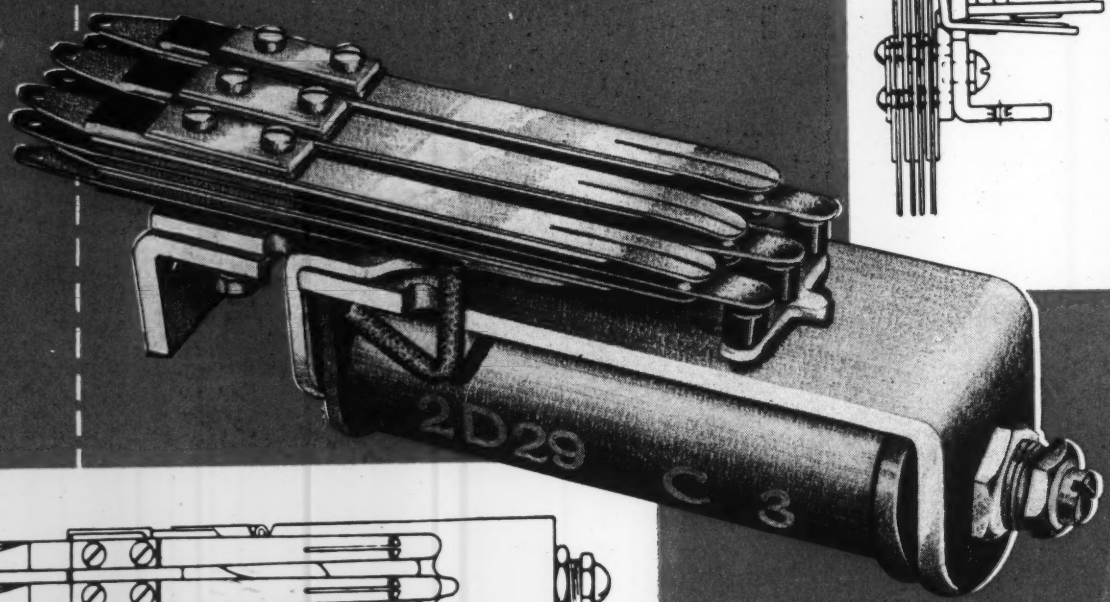
For further information, contact your nearest Louis Allis Application Engineer or write for Bulletin 1100-B.

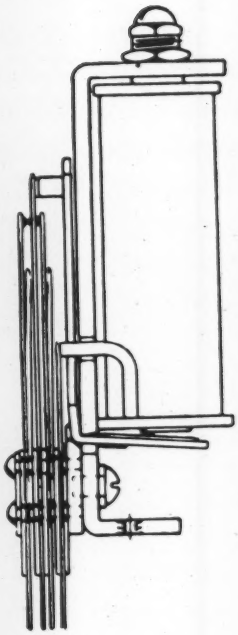
LOUIS ALLIS

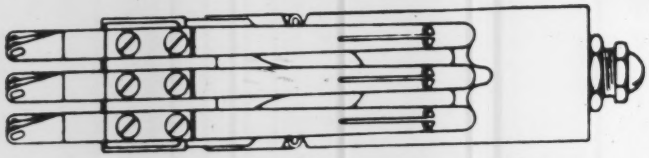
THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.

NORTH RELAYS

simple · sturdy







reliable · efficient

BECAUSE their basic principle is so simple, it's easy to believe that anyone can make relays: But, where dependability, reliability and efficiency are specified, such belief leads to certain disappointment.

If you are designing circuits requiring absolute quality, with zero failure, you must have relays backed by years of experience and a very special know-how. North Relays have just such backing. We've been in the business since 1884, engineering and producing millions of relays, from multiples to midgets, from simple single-makes to intricate pileups with any combination of makes and breaks.

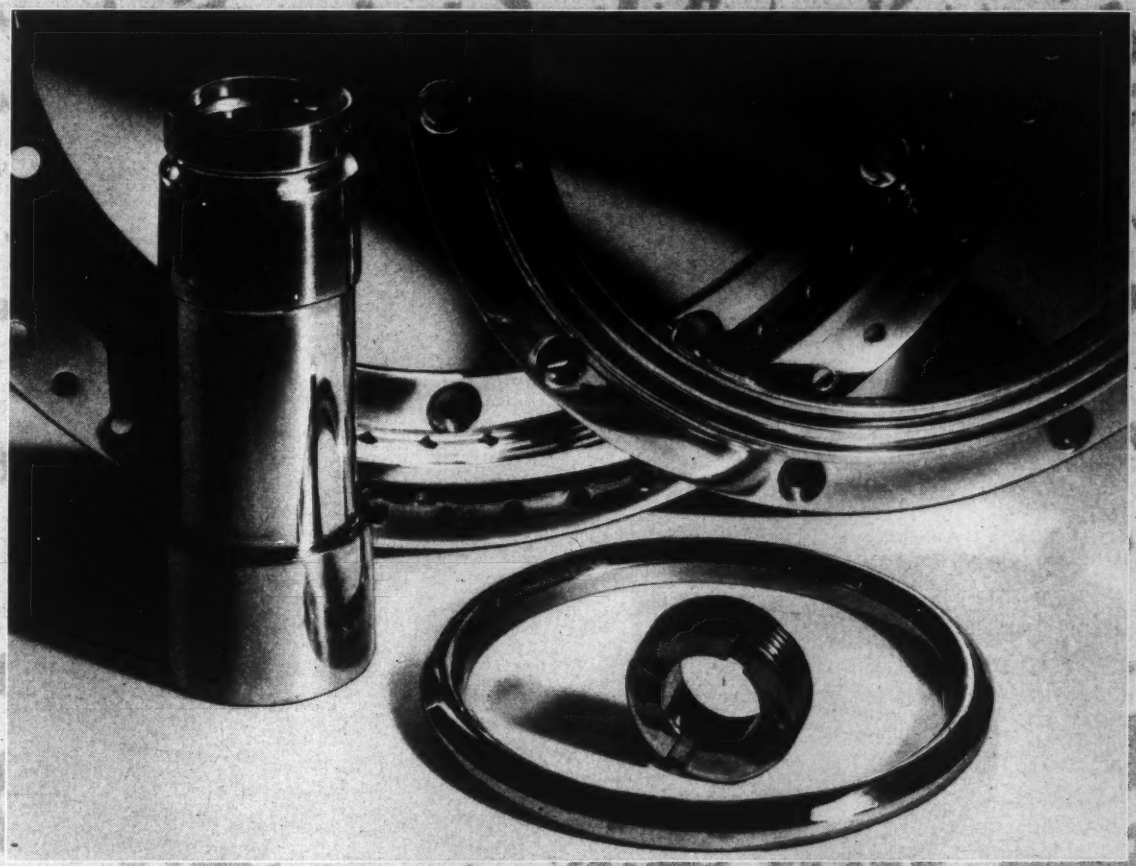
BUY NORTH for insurance on critical relay circuits.

SPECIAL RELAYS? Let North Engineer Them For You

THE NORTH ELECTRIC MANUFACTURING COMPANY

1436 South Market Street, Galion, Ohio, U. S. A.

—— Originators of ALL RELAY *Systems of Automatic Switching ——*



Regardless of alloy, shape or size the quality of Bunting Bronze Bearings is uniform. Continual chemical and physical checks and exacting foundry control by a competent metallurgical laboratory assure this. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Branches in Principal Cities.

Bunting®

44

BRONZE BEARINGS ☆ BUSHINGS ☆ PRECISION BRONZE BARS

Announcing... U·S·S

A NEW HEAT-TREATED ALLOY STEEL WITH

MECHANICAL PROPERTIES—U·S·S Carilloy T-1 Steel can be furnished Heat Treated to the following mechanical properties:

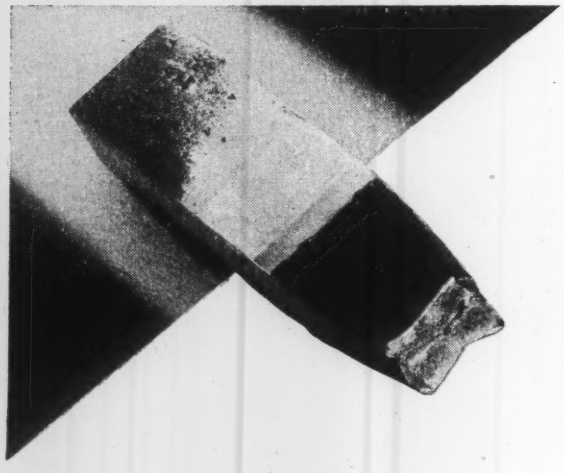
	Thickness ¼" to 2" incl.	Thickness Over 2" to 4" incl.	Thickness Over 4" to 6" incl.
Yield Strength, 2% Offset (min.)	100,000 psi	90,000 psi	90,000 psi
Tensile Strength (min.)	115,000 psi	105,000 psi	105,000 psi
Elongation in 2", % (min.)	18	17	16
Reduction of Area, % (min.)	55	50	45
	Thickness ¼" to ½" incl.	**Thickness Over ½" to 1" incl.**	**Thickness Over 1" to 2" incl.**
Cold Bend	180°D=1t	180°D=2t	180°D=3t

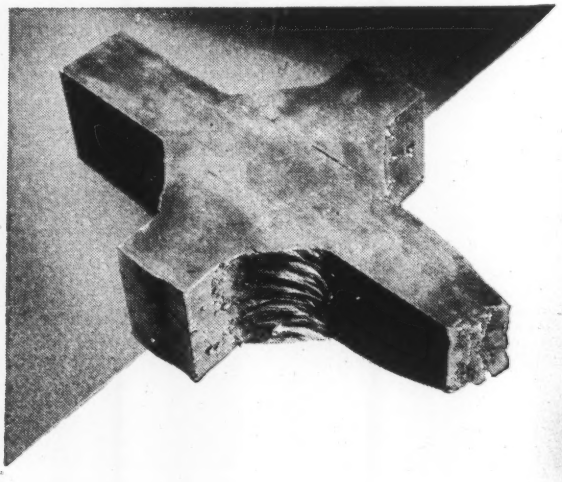
(Testing in accord with A.S.T.M. recommended practices.)

Look at these test results:

◀ **90° at 98 below!** The sample here was flame-cut from 1" plate. Then it was chilled to –98°F, and bent to a full 90° angle. Even though the raw, flame-cut edge made up the outer radius of the bend, there was no sign of failure!

▼ **100% WELD STRENGTH**—Tensile tests on welded specimens like these prove that welds on CARILLOY T-STEEL are 100% efficient. Welds develop the *full* strength of the parent metal. Note that breaks occur outside the heat-affected zone. No special pre-heating or post-heating treatments are required beyond those used with ordinary structural steels.





Carilloy T-steel

THIS REMARKABLE COMBINATION OF PROPERTIES

1. High yield strength of 100,000 psi minimum.

2. Strong and ductile even at 100 below zero!

3. Readily weldable - - without loss of strength or ductility.

HERE is a new alloy steel developed especially for heavy-duty equipment that must withstand a lot of abuse in all sorts of climates — in the scorching heat of summer and the bitter cold of winter — yet with all this, it's a steel that can be easily gas-cut and readily welded.

U·S·S CARILLOY T-STEEL was developed by Carnegie-Illinois research. It provides a unique combination of superior strength and unusual ductility. This low carbon *alloy* steel can actually be welded and gas-cut as readily as structural *carbon* steel.

Plates of CARILLOY T-STEEL from ¼" up to 2" in thickness have a minimum yield strength of 100,000 psi even *after* welding and gas-cutting. Despite this very high strength, T-Steel will remain tough and ductile at any climatic temperature. That's why CARILLOY T-STEEL is made to order for heavy-duty equipment that must operate out-in-the-open under high impact loads and without danger of failure.

The *full* strength of CARILLOY T-STEEL can be utilized in designing welded construction because the high physical properties are not affected by welding or gas-cutting.

U·S·S CARILLOY T-STEEL has been developed for use in the form of plates and bars. Its nominal hardness is 250 Brinell. For abrasive conditions, where high hardness *and* toughness and weldability are essential, hardness up to 320 Brinell minimum can be furnished.

SEND THE COUPON

Carnegie-Illinois Steel Corporation
Room 4212, Carnegie Building
Pittsburgh 30, Pa.

Please send me a copy of the Carilloy T-Steel booklet.

Name.....

Company.....

Address.....

City.....Zone....State.....

CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH

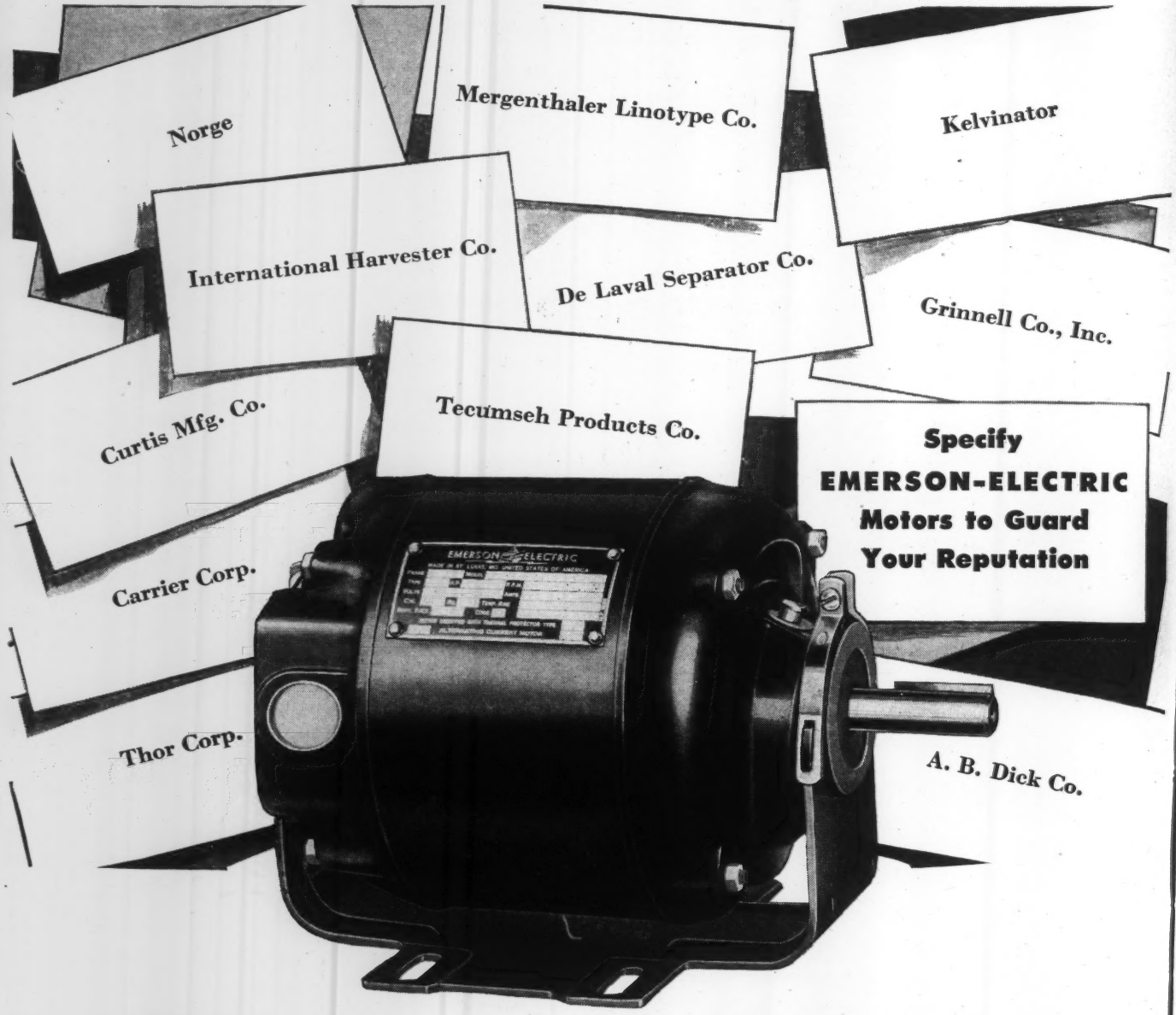
COLUMBIA STEEL COMPANY, SAN FRANCISCO • TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM

UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

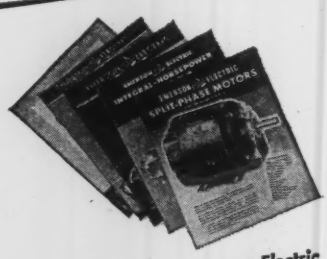
USS Carilloy Steels

ELECTRIC FURNACE OR OPEN HEARTH • COMPLETE PRODUCTION FACILITIES IN CHICAGO AND PITTSBURGH

UNITED STATES STEEL



Called upon...by American Industry



Write for these Emerson-Electric Motor Data Bulletins

Appliance and equipment manufacturers, with applications for motors of 1/20 to 5 h.p., can profitably use these authoritative reference guides. Specifications, construction details and performance data are included for the following types:

- ☐ No. 390-A Capacitor-Start Motors
- ☐ No. 390-B Split-Phase Motors
- ☐ No. 390-C Integral Motors
- ☐ No. 390-D Fan-Duty Motors
- ☐ No. 390-E Oil-Burner Motors
- ☐ No. 390-F Jet Pump Motors
- ☐ No. 390-G Blower Motors

Take a look at these famous names in American industry. They represent but a few of the scores of manufacturers who depend on Emerson-Electric to power their products . . . companies who stake their reputations on the *performance* of Emerson-Electric Motors.

Naturally, we are proud that Emerson-Electric's record of *proved* motor performance has earned the right to be associated with these names.

You may find that adding your name to those above will be the ideal answer to your motor requirements. Emerson-Electric offers you a complete line of motors in the 1/20 to 5 h.p. range . . . motors whose reputation rests on unvarying efficiency and dependability.

We welcome your inquiry. Call on, depend on Emerson-Electric for motors designed to fit your needs.

THE EMERSON ELECTRIC MFG. CO.

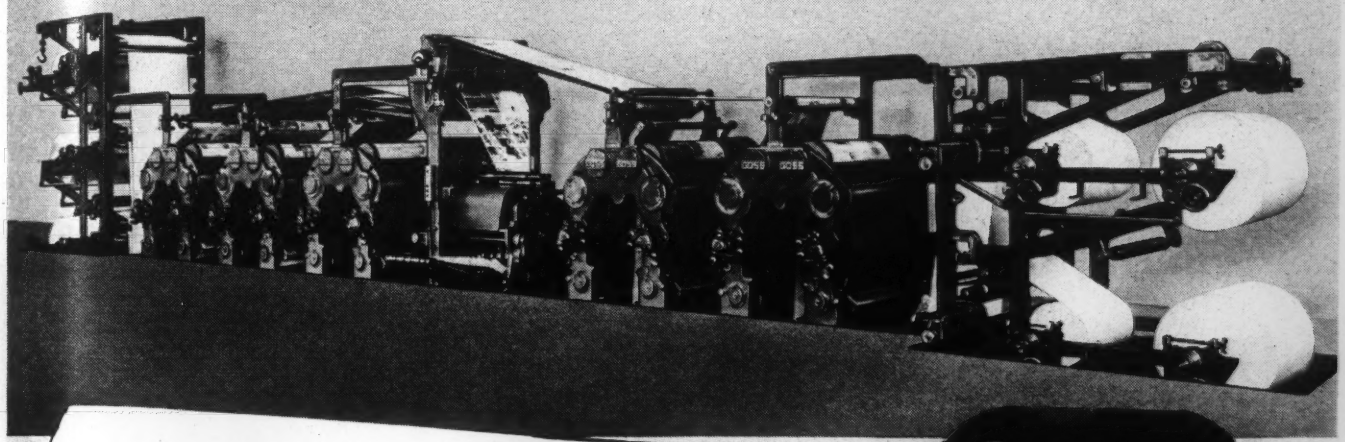
ST. LOUIS 21, MO.

EMERSON ELECTRIC

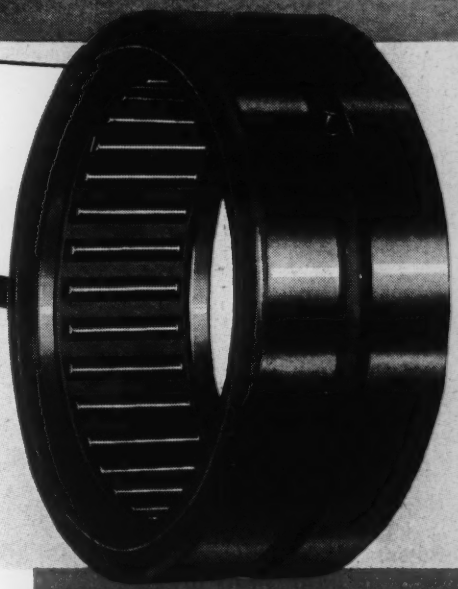
MOTORS • FANS — APPLIANCES

How's this for high speed operation?

20,000 complete 40-page newspapers an hour run off by this GOSS UNIVERSAL PRESS!



...and all cylinder journals run on ORANGE *Cage Type* NEEDLE BEARINGS!



Getting a newspaper on the street while the news is hot, calls for almost fantastic speed of printing—and every safeguard against breakdown of the presses. The Goss Printing Press Company provides both in this 40-page Universal Newspaper Printing Press. One important step is the adoption of Orange Cage Type Needle Bearings for the journals on all printing plate cylinders and impression cylinders, to withstand this high-speed operation and provide long, trouble-free bearing life.

• Orange Cage Type Needle Bearings have broadened the application of needle bearings to include high speed operation—spindles—vertical installations—overhung mountings, while minimizing the effects of misaligned mountings.

Chief reason is that all rolls are held in permanent alignment by a free-floating, land-riding cage made of anti-friction, non-ferrous metal. This prevents rolls from skewing while running. Cage pockets are coined to the contour of rolls. Internal clearances can be precision controlled to meet exacting requirements. All rolls and races are "Pentrate" finished to reduce corrosion and friction. Operation is extremely smooth and quiet, with longer life expectancy.

ORANGE

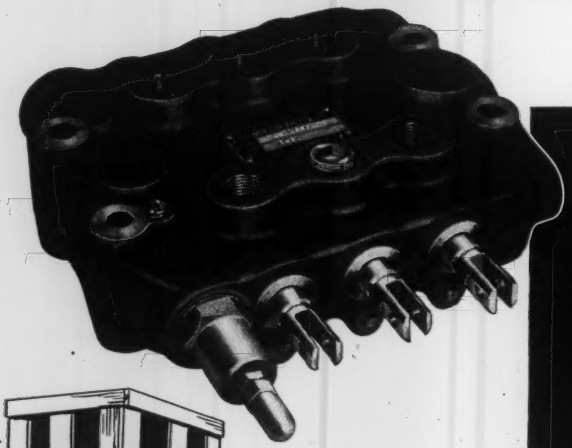
ORANGE *Cage Type* NEEDLE BEARINGS

• **WRITE for Engineering Data Folder on Cage Type Needle Bearings. Shows details of construction, advantages, dimensions, capacities, etc.**

ORANGE ROLLER BEARING CO., INC., 556 Main Street, Orange, N. J.

DO YOU USE Oil Hydraulics?

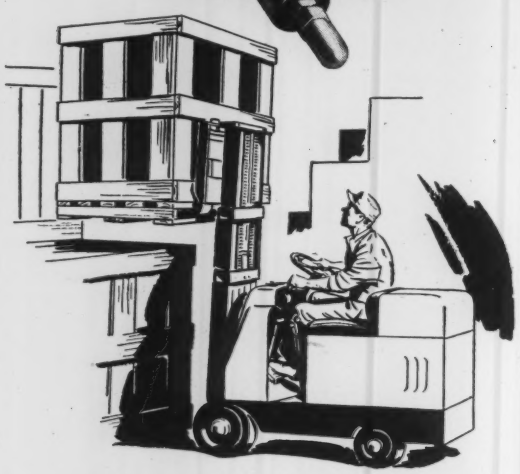
80% of all leading industrial lift truck manufacturers use...



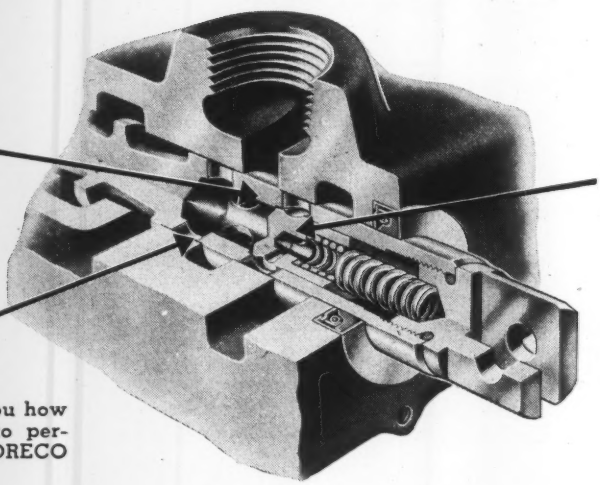
HYDRECO
HOLLOW-PLUNGER* VALVES

— for smooth and accurate control of raising, tilting and accessory operations.

HYDRECO Hollow-Plunger control valves build in the fast and safe control so necessary to proper lift truck operation. Accurate throttling characteristics, inherent in HYDRECO valves, cut out lost motion in picking up and stacking. Built-in check valves of the Hollow-Plunger design entirely eliminate momentary load drops and jerky operations. There are no dead spots in HYDRECO valve operation to create pressure peaks, damaging to the hydraulic system.



HYDRECO EQUIPPED TRUCKS CUT OPERATING COSTS FOR THEIR OWNERS.



Patented hollow plunger with no dead spots to create pressure peaks.

Circular ports are staggered in the plunger for accurate throttling.

Check valve assembly prevents pressure drop in the cylinder while pressure port is opening.

Let HYDRECO engineers show you how your equipment can be made to perform faster and safer with HYDRECO Hollow-Plunger control valves.

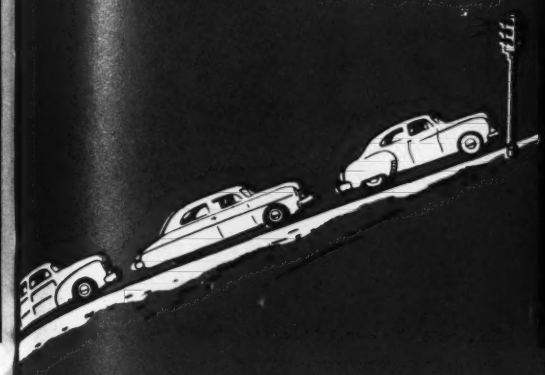
*Hollow-Plunger protected by existing U. S. and Foreign Patents as well as patents applied for.

WRITE TO —

HYDRECO
HYDRAULIC CONTROL DEVICES
PUMPS · CYLINDERS · VALVES

HYDRAULIC EQUIPMENT COMPANY
1106 EAST 222nd STREET • CLEVELAND 17, OHIO

from STOP to GO...
with shiftless driving
...via



R/M

FIRST IN FRICTION

More and more American motorists call for automatic transmission . . . and the industry meets the demand! Production of automatic units keeps going up . . . up . . . up. R/M plays an interesting part. *Every* automatic transmission now in production employs friction material made by R/M, the largest producer in the field. Some of these materials are woven, some molded; some are compounded, in whole or in part, of powdered metal; many are bonded to metal backings. Other R/M products are used constantly for clutches and brakes covering an even wider range. The experience thus gained is available to all manufacturers faced with problems in metallic and asbestos friction materials, as well as in rubber products. Your R/M representative is the man to see!

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION — **620 Fisher Bldg., Detroit 2, Mich.**

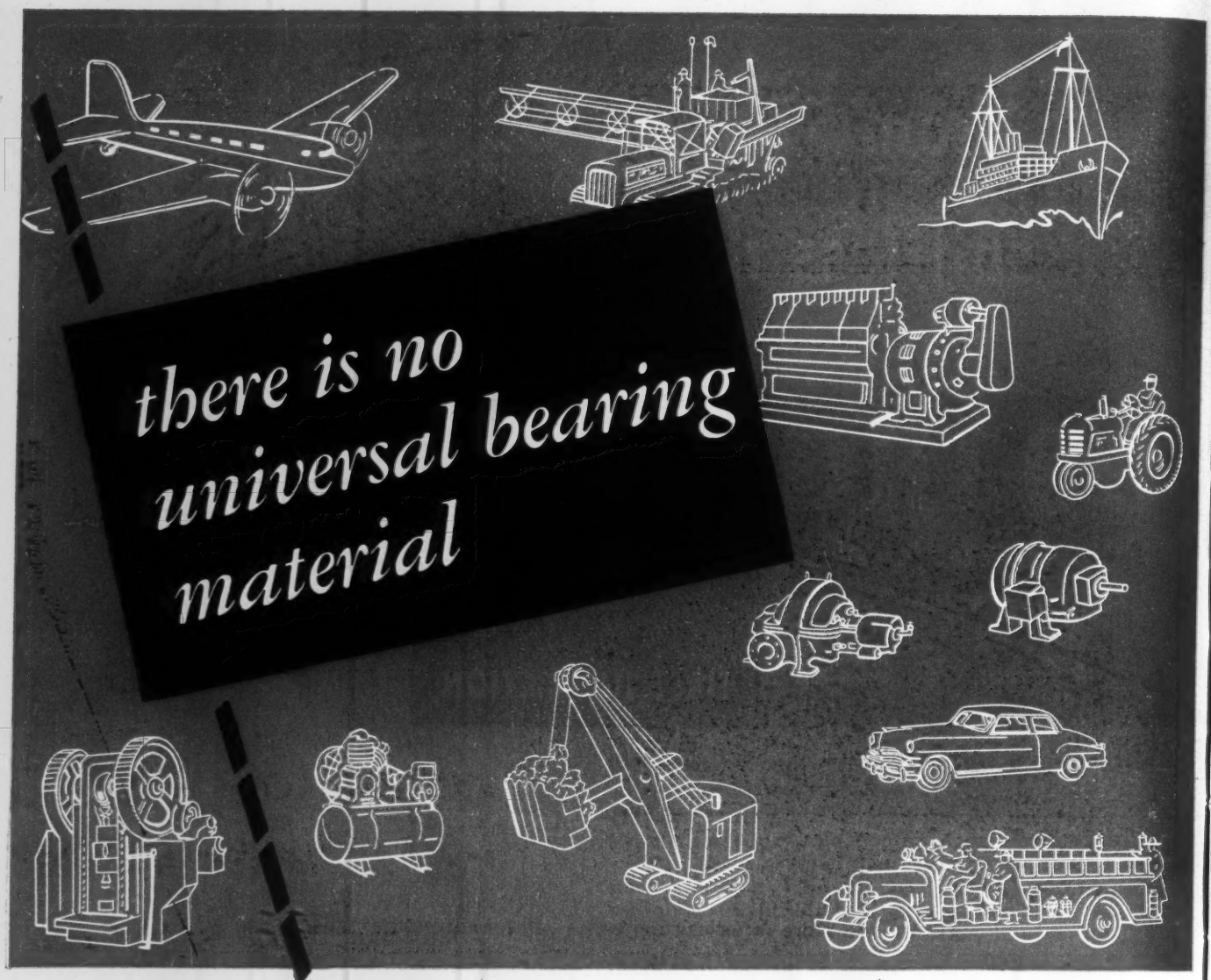
445 Lake Shore Drive, Chicago 11, Ill. — 4651 Pacific Blvd., Los Angeles 11, Calif.

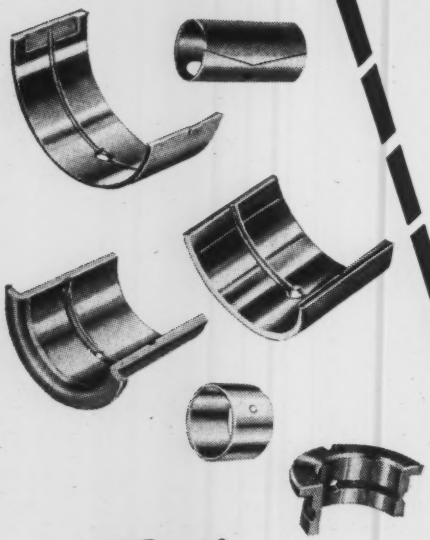
1071 Union Commerce Bldg., Cleveland 14, Ohio

Factories: Bridgeport, Conn. Manheim, Pa. Passaic, N.J. No. Charleston, S.C.

R/M

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings
Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings
Asbestos Textiles • Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls





12 MACHINES

How many different Bearings?

There may be 20, 40 or more variations and combinations of alloys and designs in the sleeve bearings. One engine may require different bearing alloys for main bearings, connecting rod bearings, camshaft bearings, piston pin bushings and water pump bushings. That's one reason why, as long-time specialists in research, design and manufacture of sleeve bearings, we specialize in *variety*. Our seven manufacturing plants produce sleeve bearings and bushings in a wide range of material combinations and sizes, in quantities from dozens to millions.

Send for handy Bulletin for your reference file. It shows the "field of usefulness" for a wide range of bearing alloys, and provides a ready reference on bearing applications for your library.

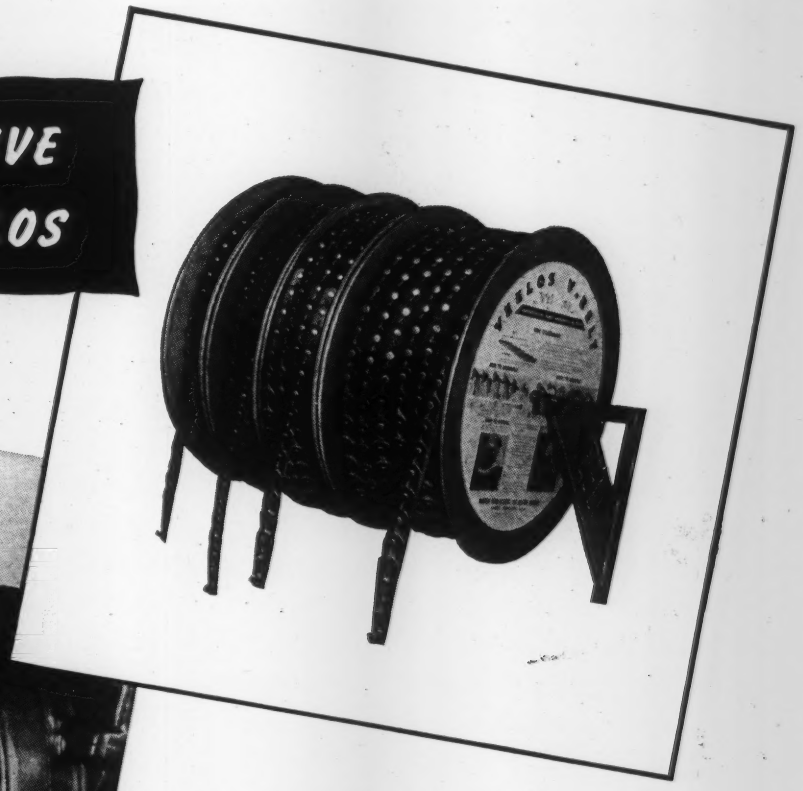
FEDERAL-MOGUL CORPORATION, 11045 Shoemaker, Detroit 13, Michigan

Silent
SLEEVE BEARINGS

FEDERAL-MOGUL

OVER FIFTY YEARS OF CONTINUOUS BEARING EXPERIENCE

SIMPLIFY YOUR DRIVE LAYOUTS WITH VEELOS



. . . and you can fit the belt to the machine . . . not the machine to the belt

YOU know the advantages of complete freedom of design when it comes to power delivery. Often machine efficiency can be stepped up by placing the motor in the most desirable position—but, because of the limitations of endless v-belts, this is not always possible.

With Veelos, the adjustable v-belt, no such limitations exist. In addition, sliding and pivoted type motor bases are not needed. Idlers are not necessary for belt take-up on fixed center drives. Outboard bearings can be used where required and Veelos can be installed without dismantling any part of the machine.

Correct belt tension, important for full, smooth power transfer, is another plus factor found in Veelos.

Veelos is made in all standard widths: 00, 0, A, B, C, D and E. It is available in three types: regular, oil-proof and static conducting. Also Veelos double V in A and B widths.

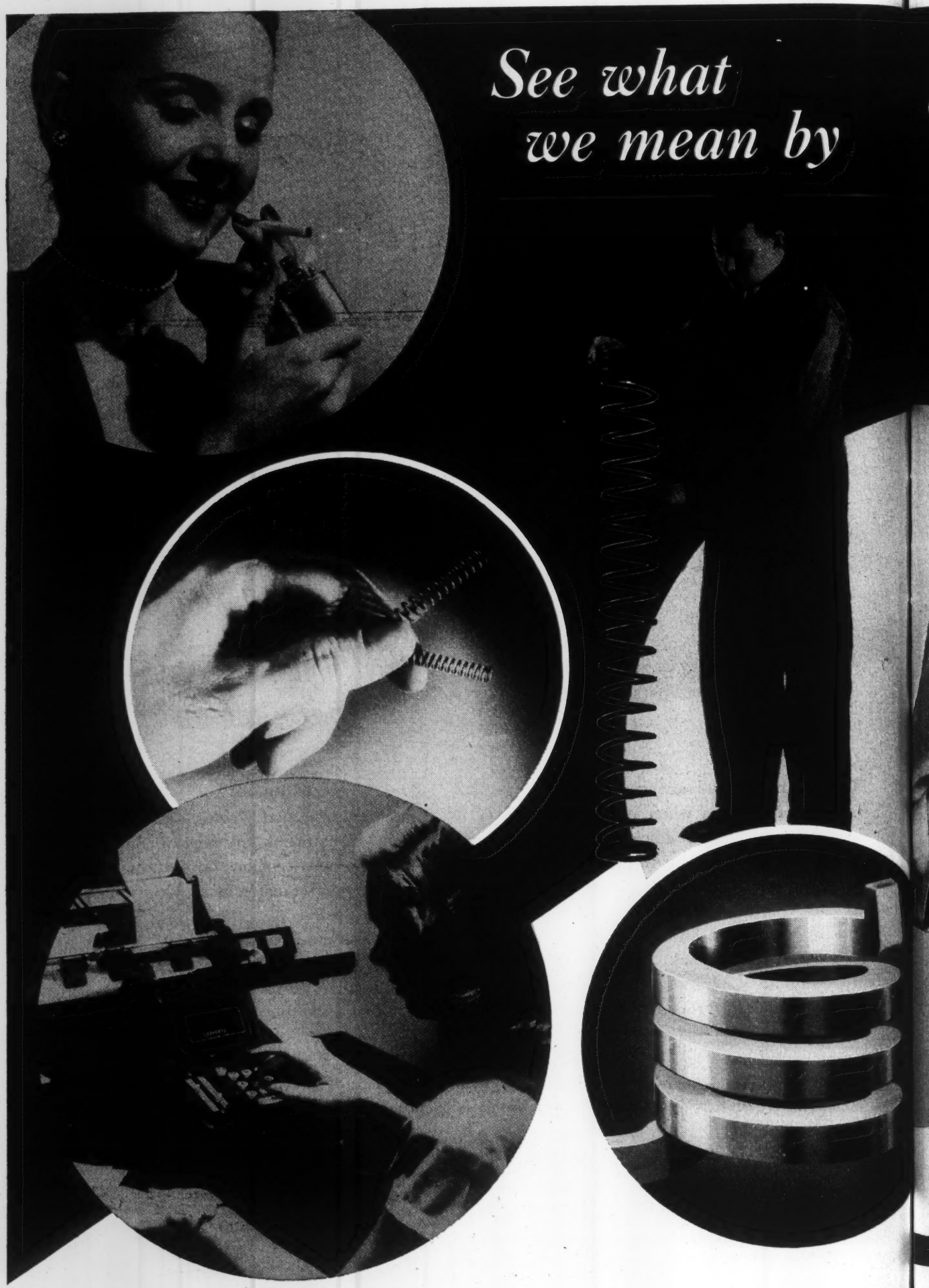
You are invited to consult our engineers on your particular v-belt needs and we believe you will find it advantageous to do so. If you do not have a copy of the Veelos Data Book let us send one on to you immediately.

MANHEIM MANUFACTURING & BELTING COMPANY • MANHEIM, PA.

VEELOS
THE LINK
V-BELT

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

Made in all standard sizes, fits all standard grooves. Packaged on reels in 100-foot lengths. Sales engineers in principal cities. Veelos is known as VEELINK outside the United States.


See what
we mean by

"Springs for every need?"

● You're looking at some of the reasons why one of our spring men recently said—"We make springs for just about everything that uses springs!"

But we take far more pride in the *quality* of our American Quality Springs than we do in the quantities we produce. That's why it has long been our policy to keep top-drawer spring men on our payrolls . . . and to have the very best spring-making equipment in our plants. These men . . . this equipment are your assurance that American Quality Springs will meet the high standards that have for years characterized *all* of our wire products.

In the matter of design, too, we feel fully qualified to offer you assistance. Our engineers have designed springs to do everything from releasing mousetraps to minimizing shock in bulldozers.

These widely-varied jobs have given them a deep reservoir of useful knowledge which may contain the right answer to some ticklish spring problem of *yours*.

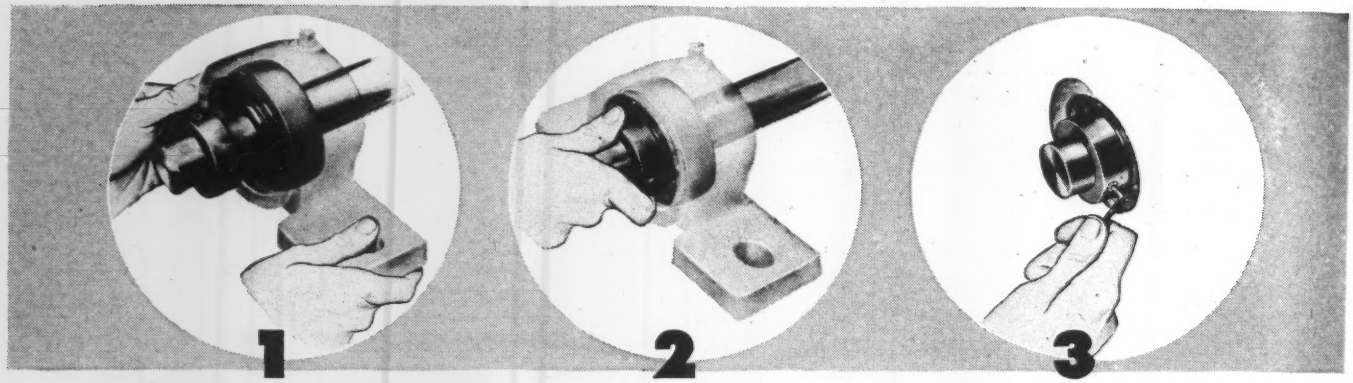
So for design, for production, and for greater peace of mind about performance, why not call, write or wire us?

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM, SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **AMERICAN QUALITY SPRINGS**

UNITED STATES STEEL

Some still say:
"It can't be that simple"



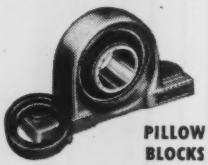
To those who have struggled with shaft shoulders, lock nuts, adapter sleeves and other gadgets for holding a bearing to a shaft it is understandable why some still say: "It can't be that simple", when they see how easy a Fafnir Wide Inner Ring Ball Bearing with the famous Self-Locking Collar slides on and fastens to a shaft.

If you believe that "seeing is believing" try Fafnir Ball Bearing Power Transmission Units on your next installation. We'll let you judge for yourself.

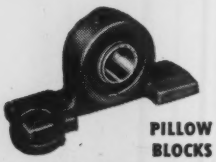
To make it simple for you, a nearby Fafnir Distributor will supply the units best suited for your requirements. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR BALL BEARING POWER TRANSMISSION UNITS

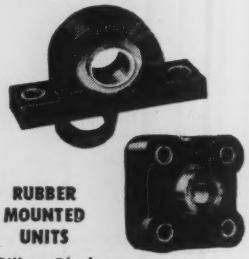
Self-aligning. Sealed for long, uninterrupted service. A type and size for every condition.



PILLOW BLOCKS
Mechani-Seal Type. Two Series: Light and Heavy



PILLOW BLOCKS
With labyrinth seals, and single or double dirt guards. Two Series: Standard and Heavy



RUBBER MOUNTED UNITS
Pillow Blocks
Flange Cartridges

It's this simple

1
Slip it over the shaft.

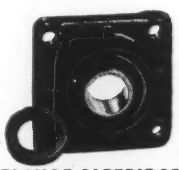
2
Engage and turn the collar.

3
Set the screw.

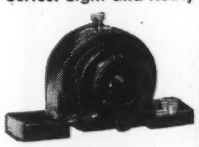
that's all

FAFNIR
BALL BEARINGS

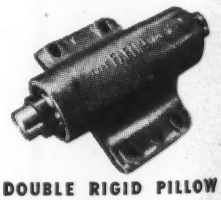
MOST COMPLETE LINE IN AMERICA



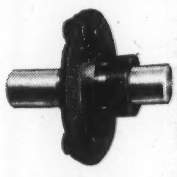
FLANGE CARTRIDGES
Mechani-Seal Type. Two Series: Light and Heavy



PILLOW BLOCKS Fixed and Floating Types. Two Series: Standard and Heavy



DOUBLE RIGID PILLOW BLOCKS Heavy Duty



FLANGETTE
With pressed steel flanges

skill to design . . . facilities to produce

SHAPES

and metal tubing

Designing and building tools and dies, as well as forming shapes and tubing in our own modern plant assures you of rigid control throughout the various phases of manufacture. This "under one roof" procedure, supervised by engineers whose knowledge of the uses which rolled shapes and tubing can serve, eliminates guesswork and delay in overall production.

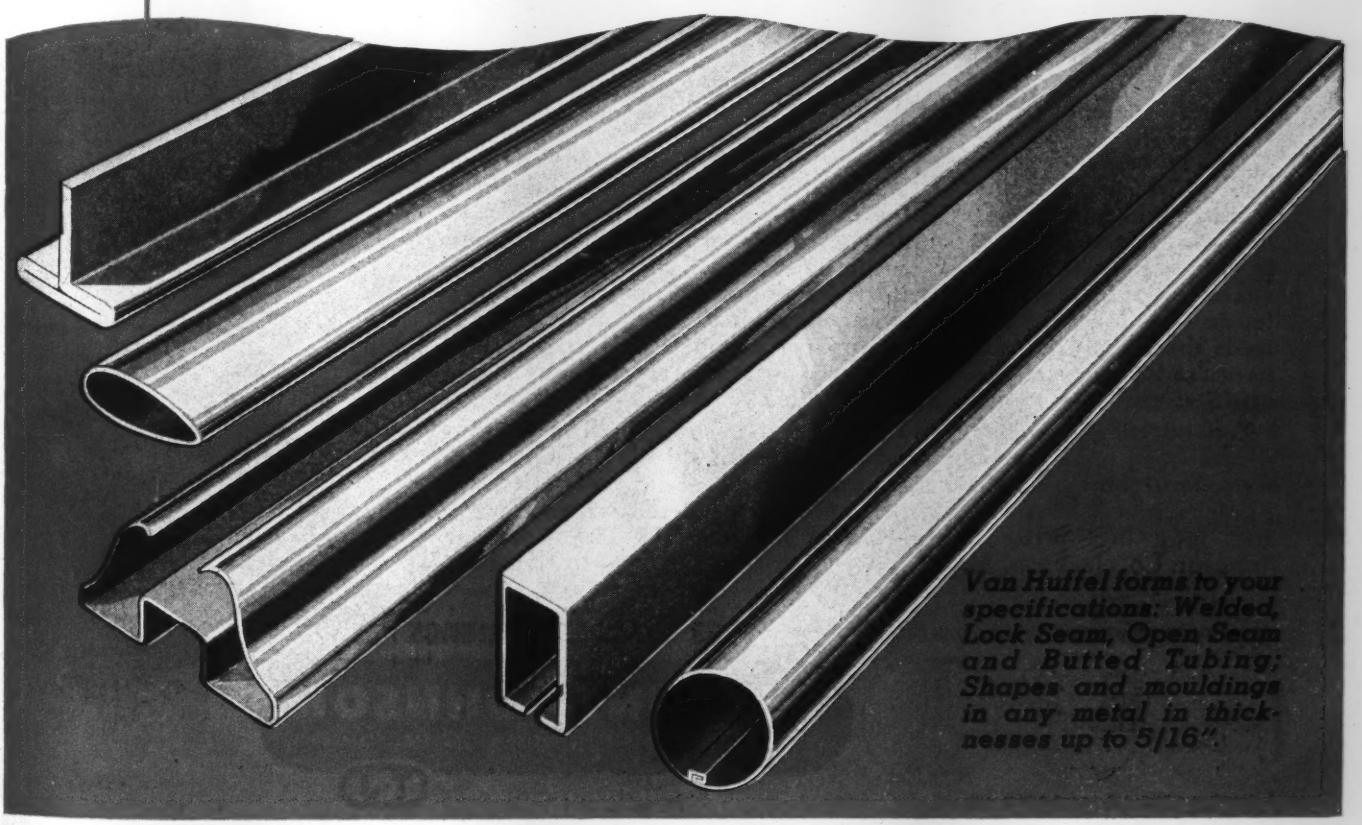
Perhaps you can use Van Huffel "know-how" and facilities to advantage. It costs nothing to find out. Write for illustrated brochure which shows the wide range and diversified application of Van Huffel Shapes and Tubing.

continuous rolled

METAL SHAPES • TUBING

VAN HUFFEL

TUBE CORPORATION · WARREN · OHIO



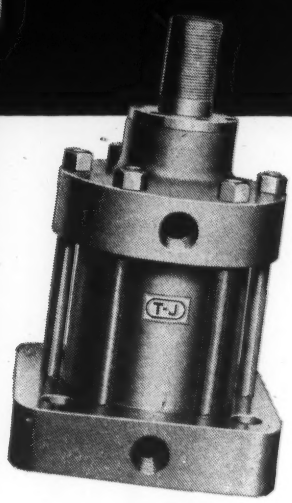
Van Huffel forms to your specifications: Welded, Lock Seam, Open Seam and Butted Tubing; Shapes and mouldings in any metal in thicknesses up to 5/16".

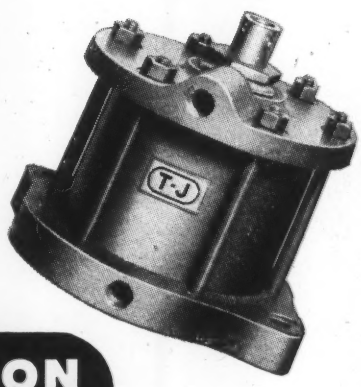
Job File No. 4617

NAILING MACHINE

feeds wood strips automatically with

T-J AIR CYLINDERS



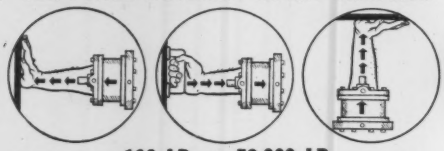


Here's a typical "push-pull" job peformed efficiently by T-J Cylinders!

This special nailing machine—equipped with T-J Air Cylinders—is built by Morgan Machine Co., Inc., Rochester, N.Y., for use by Hotpoint in Chicago. The machine is employed to make up skids for mounting electric ranges for shipment. The three boards as shown in the hoppers on top of the machine feed down one at a time while a cross piece from the hopper extended to the right of the machine is fed in. The long T-J Cylinder projecting out in front of the machine feeds the three boards ahead the proper distance and then stops to have a cross piece nailed to them. It then advances automatically to next position until four cross pieces are nailed to the three lateral strips.

For your tough jobs in power movement — pushing, pulling or lifting —*save labor, speed production* and *cut costs* with T-J Air and Hydraulic Cylinders! Many standard sizes and styles . . . both cushioned and non-cushioned types . . . 100 lb. or 50,000 lb. Precision-built, versatile, long life. Write for additional information. The Tomkins-Johnson Co., Jackson, Mich.

FOR POWER MOVEMENT IN ANY DIRECTION



100 LB. or 50,000 LB.

33 YEARS EXPERIENCE

TOMKINS-JOHNSON

RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS

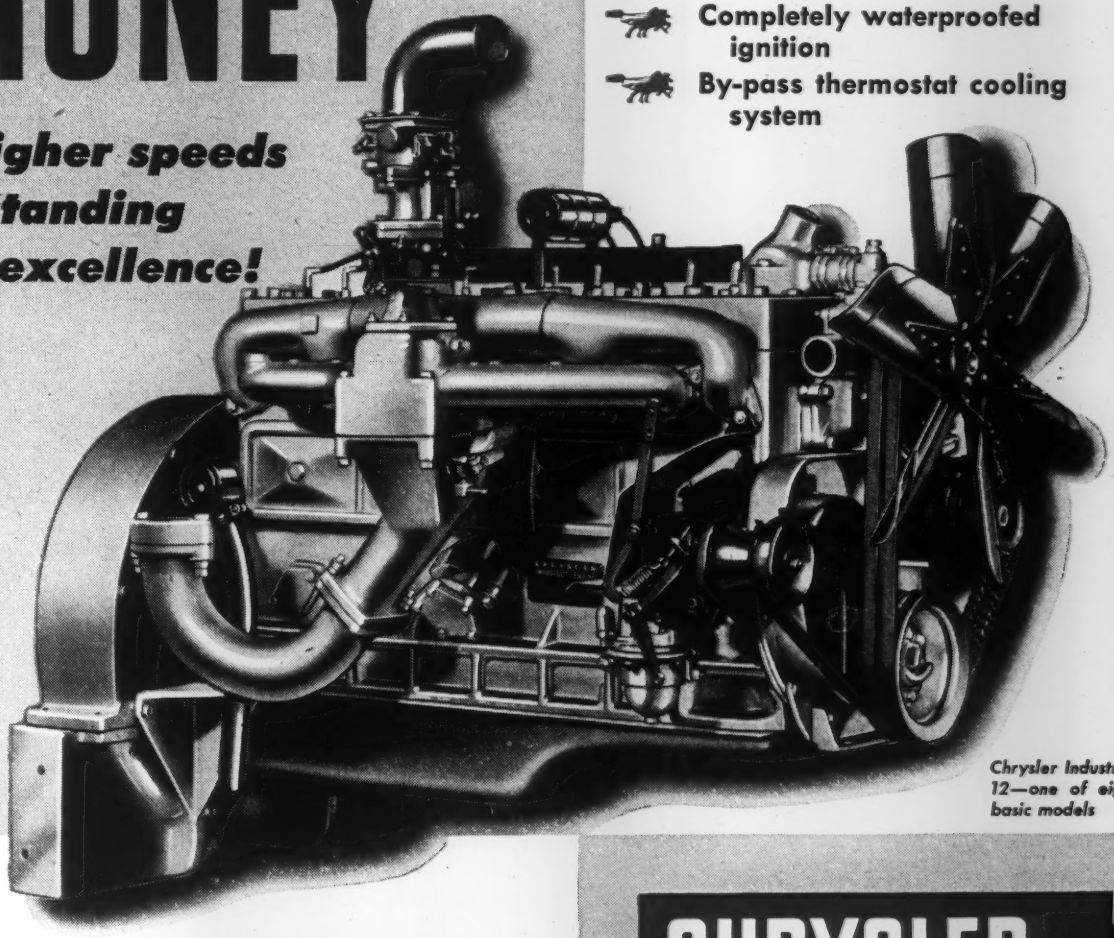
T-J

MORE POWER FOR LESS MONEY

assured by higher speeds and outstanding mechanical excellence!

Check these Features!

- All friction surfaces *Super-finished*
- Statically and dynamically balanced crankshaft
- Sodium cooled exhaust valves
- Stellite exhaust valve seat inserts
- Stainless steel valve springs
- Chrome top piston ring
- Completely waterproofed ignition
- By-pass thermostat cooling system



Chrysler Industria
12—one of eigh
basic models

THE FACT that a higher speed engine can out-perform all others has long been established. Today, after years of field operation in every type of gasoline powered equipment, it has been conclusively shown that Chrysler Industrial Engines *out-last* and *out-economize* all other similarly rated engines. The reason lies in the outstanding achievements of Chrysler engineering and Chrysler research in higher alloy steels. And because of Chrysler mass production Chrysler Industrial Engines *cost less!* See your Chrysler Industrial Engine Dealer, or write us. ***Industrial Engine Division, Chrysler Corporation, Detroit 31, Michigan.***

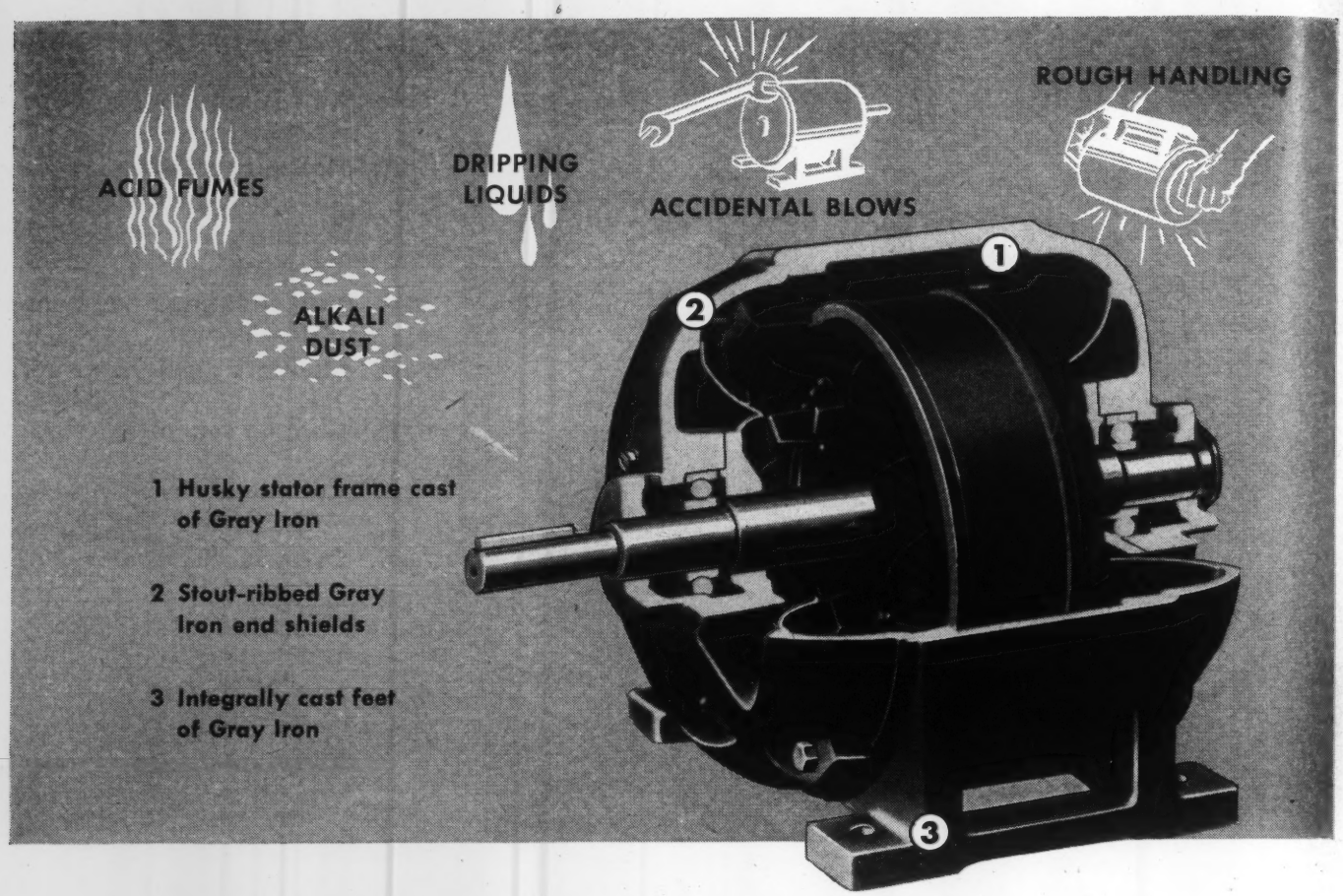
CHRYSLER

Industrial Engines and Power Units

CHRYSLER INDUSTRIAL ENGINES

HORSEPOWER WITH A PEDIGREE!

Service Available Everywhere



Where motors get ROUGH USE GRAY IRON can take it!

Typical motor end plates cast of Gray Iron

Leading motor manufacturers use Gray Iron for the following important reasons:

- Damping action that minimizes noise and vibration.
- Rigidity which insures permanent shaft alignment.
- Extra protection against jarring blows and rough handling.
- Resistance to rust and corrosion.

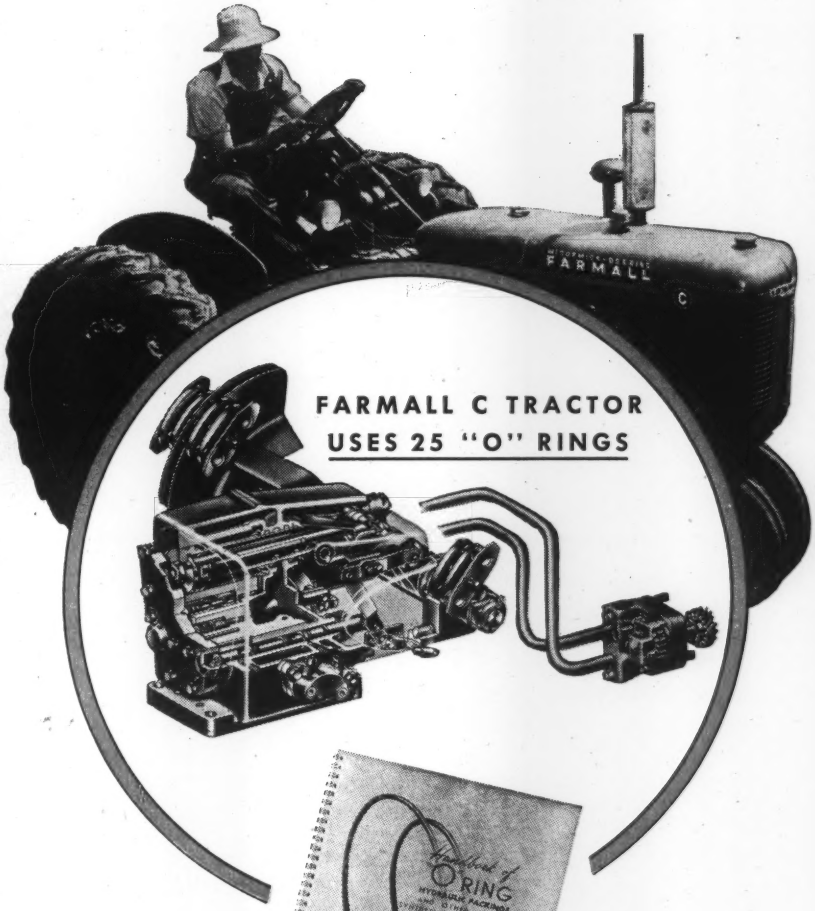
Why not take a tip from leading manufacturers and specify Gray Iron where your product must stand up under rough usage? Whether it's corrosion, abrasion, heat or vibration . . . Gray Iron can take it!

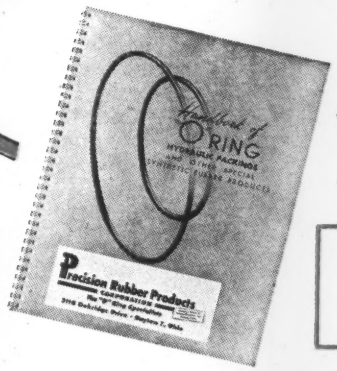
Make It Better with Gray Iron . . . Second largest industry in the metal-working field.

GRAY IRON FOUNDERS' SOCIETY, INC.
NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

EASY DOES IT!

...with "O" Ring Seal Designs!





Send for your free copy of our "O" Ring Handbook—learn how "O" Ring Seals can help make yours a better product.

PRP "O" RINGS *meet all J.I.C. Standards*

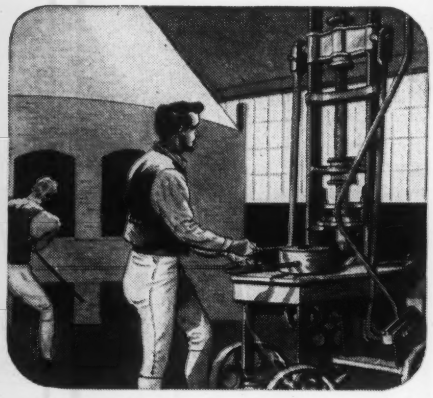
An outstanding feature of the new INTERNATIONAL HARVESTER COMPANY Farmall Cub, Super-A and C Tractors is the built in, package type, Touch-Control hydraulic system which actuates the mounted implements.

Precision Rubber Products Corporation has long cooperated in the adaptation and has been the major supplier of the 25 "O" Ring Seals (15 of them moving) that are used to seal the hydraulic fluid in the system and assure effortless and instantaneous control of the implements.

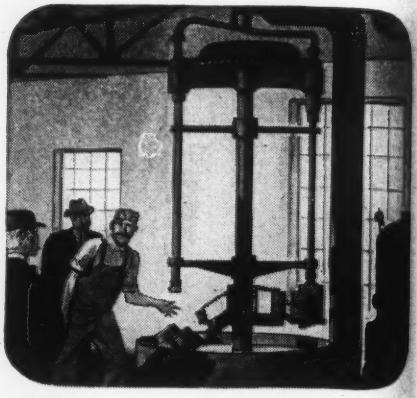
"O" Rings are economical, reliable, will save weight and space. They will help simplify your product and your production problems. PRP "O" Rings are made from a number of special synthetic rubber compounds. Let us select and recommend the best compound for service with your fluid. Why not ask PRP engineers to help you with possible adaptations? WRITE TODAY!

Precision Rubber Products
CORPORATION
Formerly Plastic & Rubber Products, Inc. Dayton, Ohio
The "O" Ring Specialists
Box 431, Dayton 1, Ohio

1 **1621**—Glass was money! America's first glass factory was actually a mint—not for the manufacture of coins but to make glass beads for *use* as money when buying land, food and furs from the Indians.



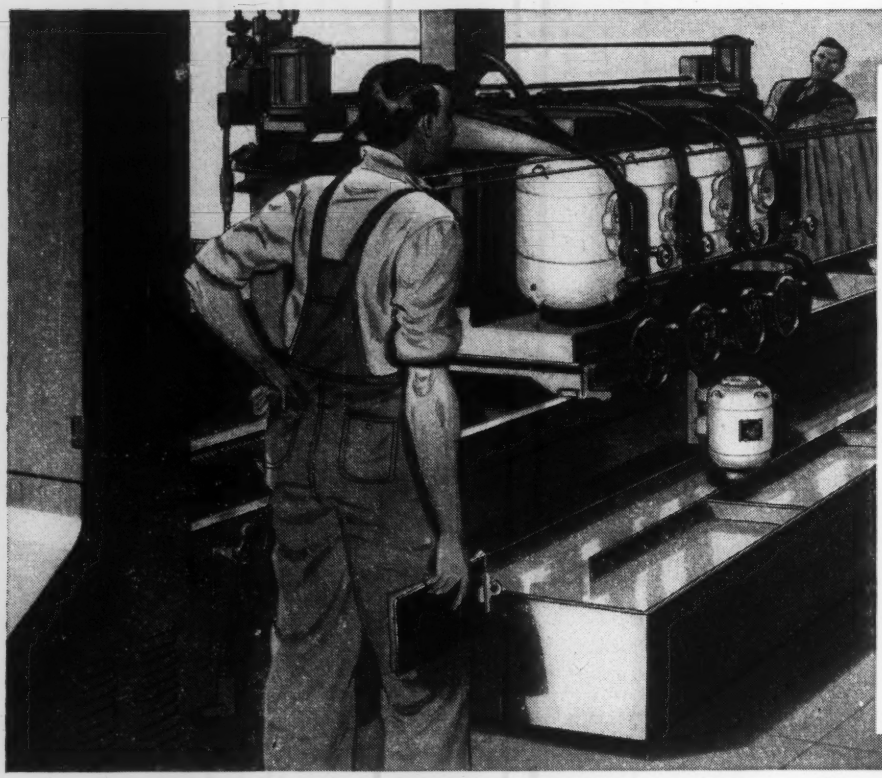
2 **1827**—Blown glass was the rule until Enoch Robinson, a carpenter, figured glass could be *pressed* into shape . . . the glass pressing machine was born. Electricity to power new machines was still to come.



3 **1899**—Owens invented a machine to make bottles as the machine age arrived in glass. By 1915, Howell "Red Band" Motors were making important contributions to this and other industries.

ANOTHER HOWELL SUCCESS STORY

GLASS...from artisans to automatic machines



4 **Today**—Modern, electrically driven machines have improved quality, cut costs and increased output in the glass making industry. For example, this unique glass beveling machine, equipped with 7 dynamically balanced Howell Motors, *automatically* bevels glass at the rate of 2,000 inches per hour!

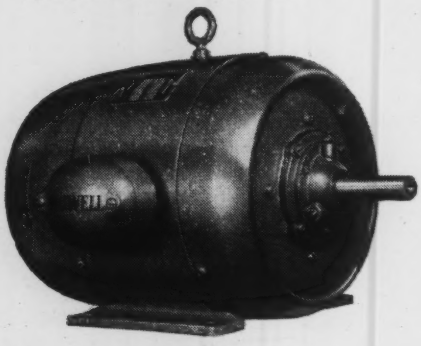
You'll also find precision-built Howell Industrial Type Motors powering bottle and bulb machines, conveyors, grinders, polishers, plate and window machines in the glass industry.

Elsewhere, Howell's wide range of standard NEMA motors, and special motors designed to customer requirements, serve dependably and efficiently under the toughest conditions.

For a really profitable investment, buy HOWELL!

Free enterprise encourages mass production, supplies more jobs — provides more goods for more people at less cost.

Howell totally enclosed, fan-cooled motor—windings completely sealed against dirt and weather.



HOWELL MOTORS

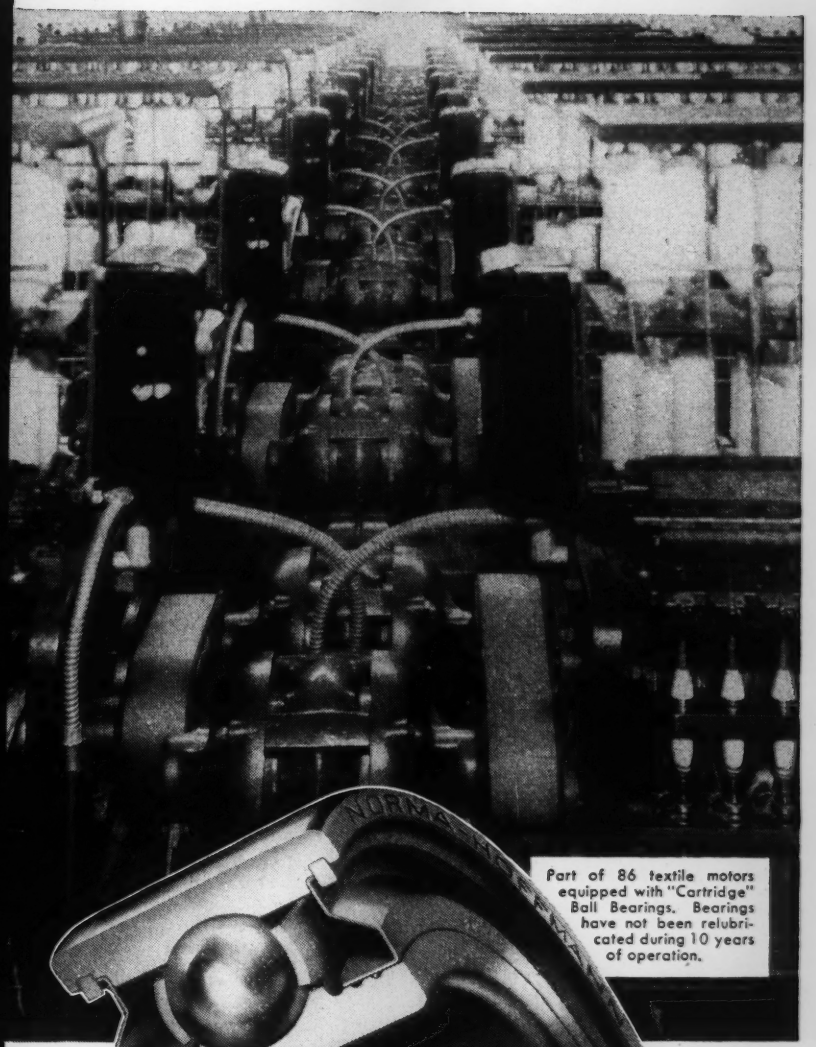
HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

HOWELL Red Band MOTORS

CASE HISTORY #819

646 Motors Operate 8 to 10 Years Without Relubrication or Bearing Failures ...and they're still going strong



Part of 86 textile motors equipped with "Cartridge" Ball Bearings. Bearings have not been relubricated during 10 years of operation.

Norma-Hoffmann

Patented "Cartridge" Bearings increase the "Life-Span" of Equipment

Records prove that Norma-Hoffmann "Cartridge" ball bearings give continuous performance in hundreds of applications without failure.

For example — 646 motors in 5 textile mills have been operating practically continuously for 8 to 10 years without relubrication. On inspection of many of the motors, the bearings showed no appreciable wear and the original grease was in good condition for many more years of operation.

Made to double-row width, Norma-Hoffmann "Cartridge" bearings have 100% more grease capacity than conventional width sealed bearings. The highly efficient seals keep dirt out, grease in. Factory-packed with Norma-Hoffmann's specially compounded "stability-tested" grease . . . grease that is highly resistant to oxidation and breakdown . . . assures dependable operation for long periods without regreasing.

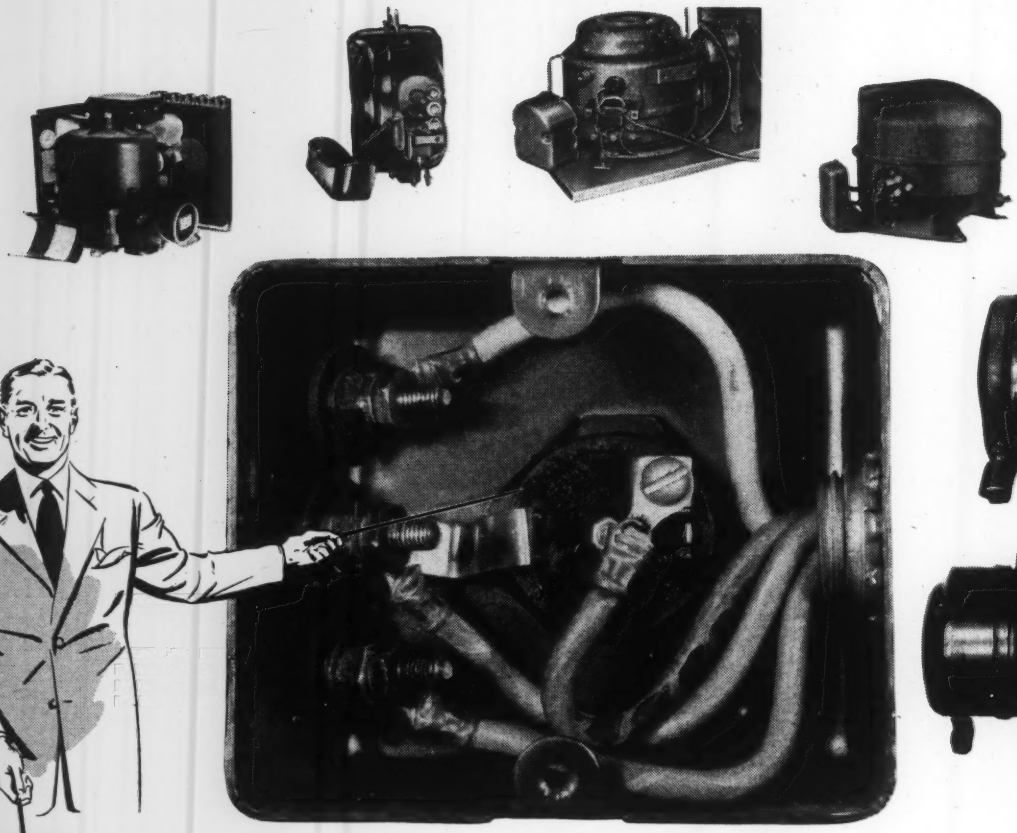
Investigate the "Cartridge" ball bearing for your products whether they be motors, machine tools, pumps or other machinery. Our engineers are always available for consultation about your bearing applications. Write for their services.

NORMA-HOFFMANN *Precision* **BEARINGS**

BALL • ROLLER • THRUST

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONNECTICUT

FIELD OFFICES: CHICAGO • CLEVELAND • DETROIT • CINCINNATI • LOS ANGELES • SAN FRANCISCO • DALLAS • SEATTLE • PHOENIX



Another Hermetic Unit Gets

Positive Burnout Protection

WITH

KLIXON *Dome Mounted* PROTECTORS

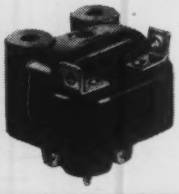
Illustrated, above, is the installation of a Klixon Dome-Mounted Protector in a well-known hermetic unit. Actual operating experience proves that the units protected by Klixon Protectors give years of trouble-free service without burning out.

Here's why — mounted on the dome where they follow every motor temperature change, Klixon Protectors shut the power "off" should the motor become dangerously overheated, regardless of the cause. Then, when the motor cools sufficiently, they snap the power "on" again automatically, enabling the unit to maintain refrigeration.

Because Klixon Protectors provide positive motor burnout protection, they enable the hermetic manufacturer and user to get maximum useable capacity from the motor. This means that smaller HP hermetic units can often be used . . . or the refrigeration capacity of the same unit can be stepped up.

Whether you use hermetic units, oil burners, or other electric motor driven appliances, it will pay you to specify motors with Klixon Protectors. They will reduce your service calls, minimize repairs and replacements . . . help you build and maintain customer goodwill.

KLIXON MOTOR STARTING RELAYS



These dependable relays complete the combination for starting and protecting the motor. Their positive action and long life eliminate starting troubles.

Used and recommended by leading Refrigeration manufacturers.

KLIXON

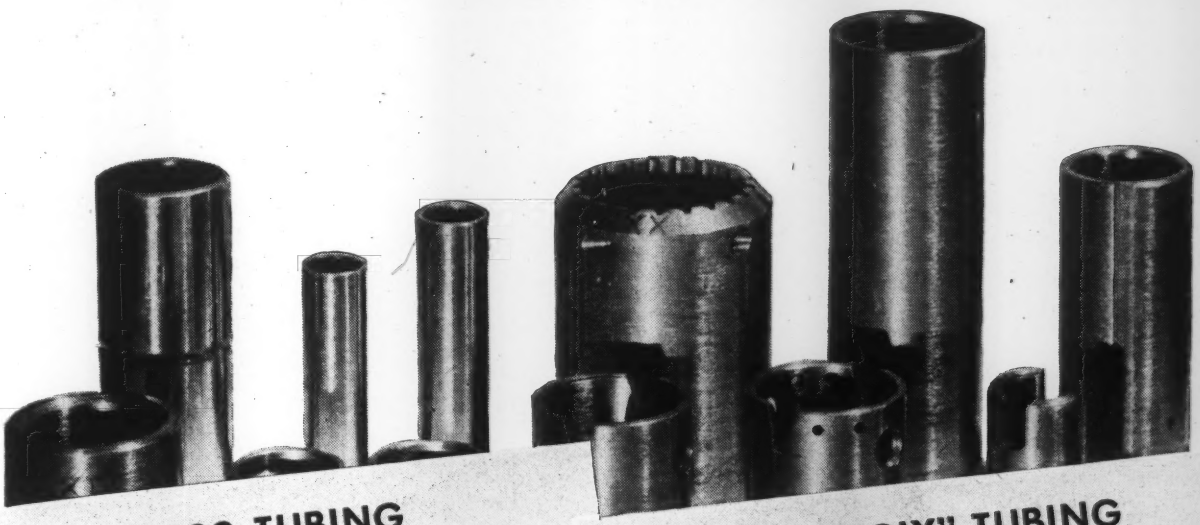
TRADE MARK REG. U. S. PAT. OFF.

SPENCER THERMOSTAT

Division of Metals & Controls Corp.

2512 FOREST STREET, ATTLEBORO, MASS.

In a rush? Two TIMKEN® steels will do 90% of your hollow-parts jobs!



52100 TUBING

101 STOCK SIZES

HIGH CARBON CHROME STEEL—A DIRECT-QUENCHING STEEL WHICH GIVES THROUGH HARDNESS IN MODERATE SECTIONS.

Typical applications:

aircraft parts
slitter knives
bearing races
pump parts and plungers
collets
bushings
spindles
grinding machines
precision instruments

"NICKEL-MOLY" TUBING

52 STOCK SIZES

LOW CARBON NICKEL-MOLY STEEL—A CARBURIZING STEEL WHICH GIVES HIGH SURFACE HARDNESS WITH A TOUGH CORE.

Typical applications:

piston pins
bearing races
farm equipment
knitting machinery
sleeves
bushings
pump parts
perforating guns

IMMEDIATE DELIVERY OF WAREHOUSE LOTS!

WHEN rush jobs call for a little tubing in a big hurry, get in touch with Timken®. Warehouse lots of Timken 52100 tubing and Timken "Nickel-Moly" tubing can be shipped to you within 24 hours after receipt of order.

These two general purpose steels have good hardenability and wear resistance. They'll do 9 out of 10 of your hollow-parts jobs. Timken 52100 steel can be heat treated to file hardness and tempered back to any point you want. It has through hardenability in moderate sections. Timken "Nickel-Moly" is a fine-grained, carburizing steel that develops exceptional shock-absorbing qualities when heat treated.

You can depend on uniform, high quality in every shipment, too. The Timken Roller Bearing Company maintains complete, rigid quality control through every step of manufacture. For the latest information on available sizes, grades and finishes, write for stock lists. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO"

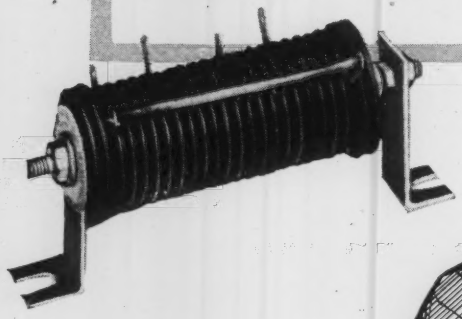
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

high voltage
Selenium Rectifiers

Make your own COMPARISON TEST

Know Which Is Best



Since most selenium rectifiers look alike, but vary greatly in quality, it is important to the user to have some simple means of determining quality. Side-by-side comparison tests are the time-honored way to compare quality. Take any 26-volt RMS selenium rectifier stack on the market—get a new G-E high-voltage stack of similar ratings and see for yourself which is the better.

These new G-E 26-volt cells thrive on comparison tests because they are outstanding in the three characteristics which mean quality in selenium rectifiers.

LOW FORWARD RESISTANCE

G.E.'s new 26-volt cells have extremely low forward resistance. This means a low voltage drop giving higher output, cooler operation, and greater rectifier efficiency. This often results in savings to you in the design and costs of other circuit components.

LOW BACK LEAKAGE

Since reverse current through a rectifier serves no useful purpose but does increase losses and heating, the low back leakage of these cells results in higher output, higher efficiency, and cooler operation.

DEPENDABLE LONG LIFE

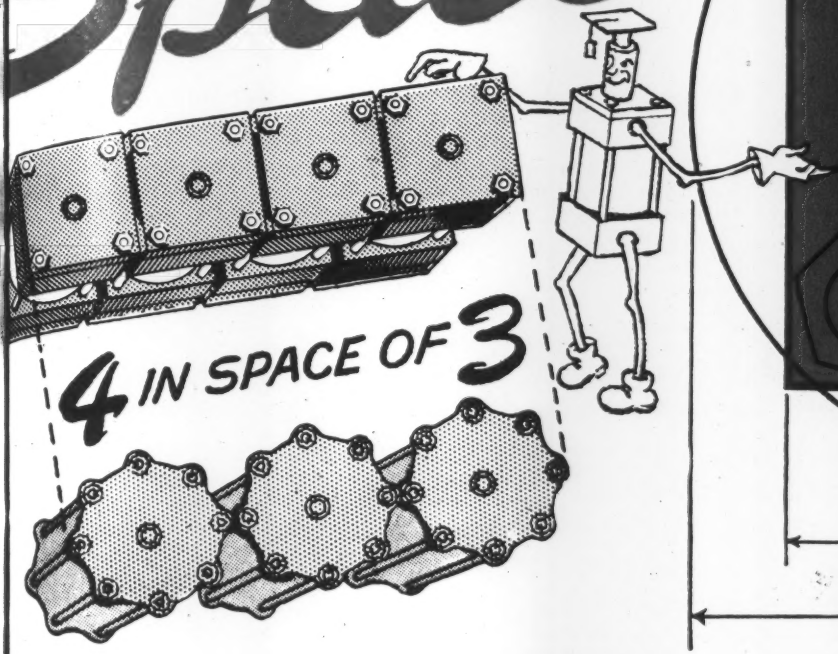
These cells are the slowest aging of any selenium cells we have tested. These dependable cells have a life expectancy of well over 60,000 hours.

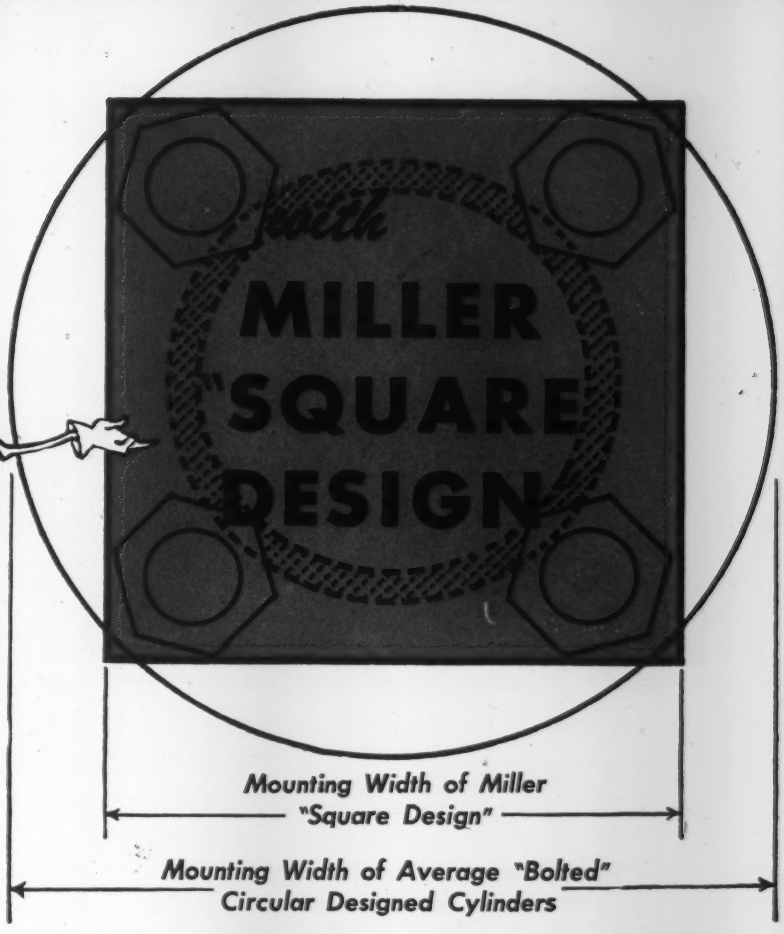
Prove for yourself the superiority of these new G-E selenium cells. *Write Section 461-13, Apparatus Department, General Electric Company, Schenectady 5, New York* for a copy of GEA-5524 which gives complete instructions for comparative testing. Contact your local General Electric Apparatus Sales Representative or authorized G-E agent to arrange your sample purchase.

GENERAL ELECTRIC

461-13

Save Space





Air *and* Hydraulic CYLINDERS...

The SQUARE DESIGN of Miller Cylinders saves up to 25% of mounting space, permitting more cylinder power in the same space and easier, more convenient installation in "tight spots." Thus, in many cases, machines and equipment can be designed more compact and less costly by using Miller Cylinders. Hours of drafting time can be saved — as only a few straight lines show any view on drawings.

The illustration at upper left shows graphically how *four* Miller Cylinders can be mounted, bore for bore, in the same space required for *three* average "bolted" circular designed cylinders. Some Miller bore sizes permit even greater space-savings.

Other important *standard* features of all Miller Cylinders include: solid steel heads, caps and mountings, hard chrome plated piston rods, dirt wiper seals, and other "quality" features as shown in illustrated bulletins sent FREE on request. Remember, too, that Miller Hydraulic Cylinders (2000-3000 psi) meet the J. I. C. Hydraulic Standards.

Write for illustrated cylinder bulletins A-105 and H-104

COMPLETE MILLER CYLINDER LINE INCLUDES: AIR CYLINDERS, 1½" to 20" BORES, 200 PSI OPERATION; LOW PRESSURE HYDRAULIC CYLINDERS, 1½" TO 6" BORES FOR 500 PSI OPERATION, 8" TO 14" BORES FOR 250 PSI; HIGH PRESSURE HYDRAULIC CYLINDERS, 1½" TO 12" BORES 2000-3000 PSI OPERATION. ALL MOUNTING STYLES AVAILABLE.

Miller
TRADE MARK REGISTERED

Benefits to you!

- More Cylinder Power in Same space
- Solve "Limited Space" Problems
- Simplify Designing and Installation
- Save hours of Drafting Time

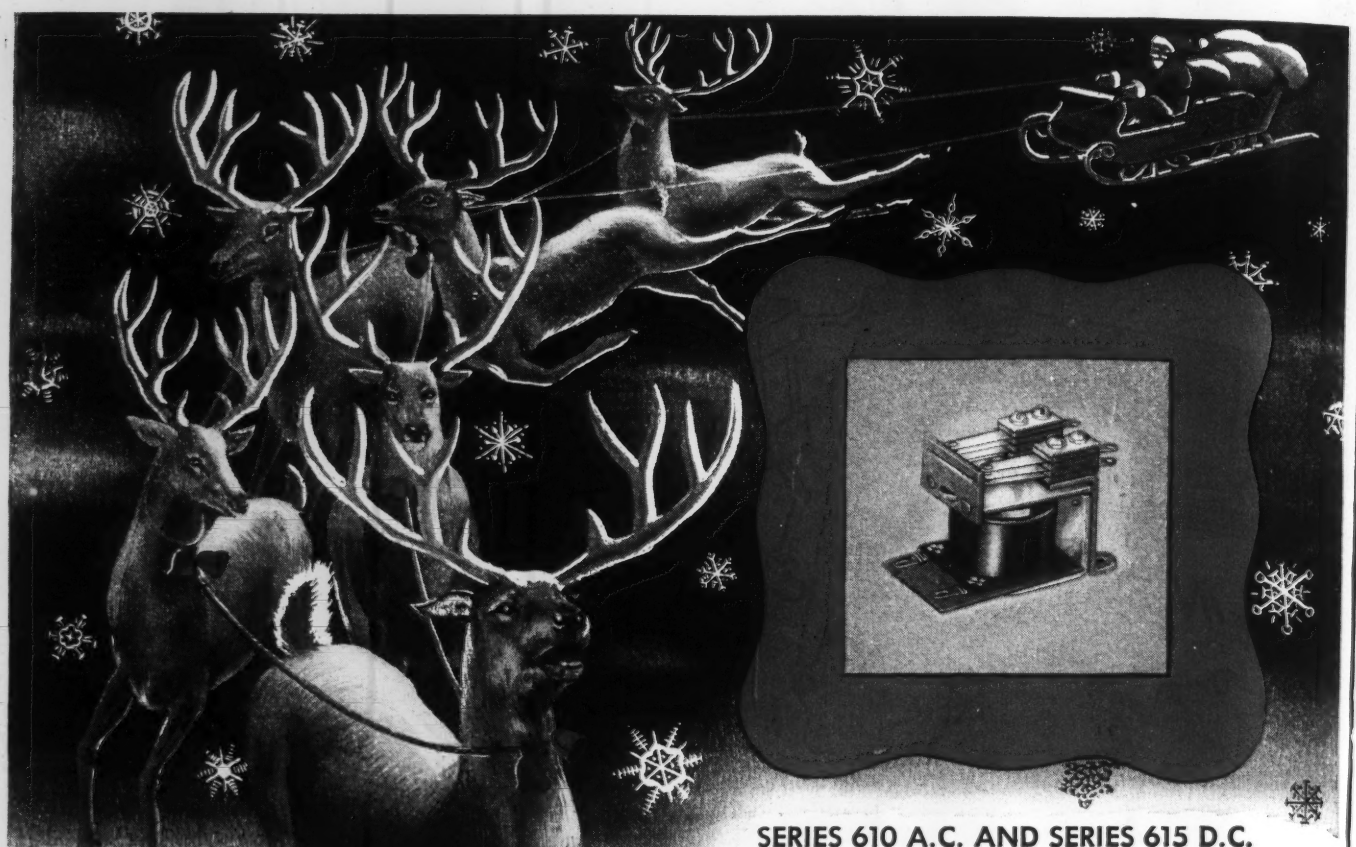
MILLER MOTOR COMPANY

4025 N. KEDZIE AVENUE - - CHICAGO 18, ILLINOIS

AIR AND HYDRAULIC CYLINDERS · ACCUMULATORS · COUNTERBALANCE CYLINDERS · BOOSTERS · AIR HOISTS

CLEVELAND — PITTSBURGH — PHILADELPHIA — DETROIT — YOUNGSTOWN — BOSTON — HARTFORD — NEW YORK CITY — DAYTON — ST. PAUL — FORT WAYNE — INDIANAPOLIS — MILWAUKEE — NASHVILLE — SEATTLE — LOS ANGELES — SAN FRANCISCO — BALTIMORE — ST. LOUIS and OTHER AREAS.

les and Service from coast to coast



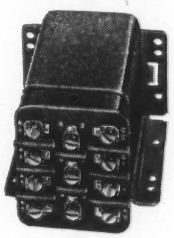
SERIES 610 A.C. AND SERIES 615 D.C.

One of a line

Relays BY GUARDIAN

CHRISTMAS OR CONVOYS . . . For peacetime products or national defense—let Guardian be your first line supplier.

The Guardian 610 A.C. and 615 D.C. Relay shown above is small and low priced, yet packed with power. Furnished hermetically sealed with the Screw Terminal housing shown, Octal Plug, or A.N. Connector housing.



The Guardian Hermetic Seal Screw Terminal Housing

Write— ASK US TO MAKE SPECIFIC RECOMMENDATIONS. NO OBLIGATION.

GUARDIAN ELECTRIC

1601-P W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

HELPFUL LITERATURE
FOR DESIGN EXECUTIVES

75. Electric Clock Movements
Sessions Clock Co.—12-page illustrated bulletin No. CM-10 contains complete information and detailed scale drawings of full line of clock timing movements. Compact design and ease of installation allow wide range of uses. Demountabe motor feature allows quick assembly and easy adjustment.

76. Air Vibrators
SPO, Inc.—8-page illustrated catalog 50 describes line of pneumatic vibrators and accessory items. Eight standard types of vibrators are covered and their over-all dimensions, weights, piston diameters and air consumption listed in chart form. Units can be used on bins, hoppers and chutes handling powdered or granular materials.

77. Self-Locking Nuts
Boots Aircraft Nut Corp.—24-page illustrated general catalog "Self-Locking Nuts" covers hexagon, anchor, floating anchor and gang channel nuts. Hex-Lok, Rol-Top, Bellows and wing styles are shown. Data on sizes, materials, heat ranges, types of anchor bases and dimensions are included.

78. Lubrication Systems
Lincoln Engineering Co.—8-page illustrated condensed catalog form 1-2470 describes standardized, centralized, mass lubrication systems for use in metal producing, metal working, mining, construction and other industries. Manual, semiautomatic and automatic systems are featured. Fittings, drum pumps, grease guns, lubricant dispensers and allied equipment are also discussed.

79. Hardfacing Alloys
Air Reduction Sales Co.—20-page illustrated catalog contains description of Airco line of hardfacing alloys and includes typical uses, mechanical properties, chemical analyses and brief outline of recommended procedures.

80. Flexible Hose Lines
Aeroquip Corp.—6-page illustrated folder No. 113 gives detailed data on line of detachable reusable fittings for flexible hose lines. Information is included on self-sealing couplings which permit separation of lines without loss of fluid. Breakaway couplings for hydraulically-operated equipment are described.

81. Investment Casting
Investment Casting Co.—4-page leaflet "The Investment Casting Process" explains method of producing tool, machine and equipment parts to tolerances of 0.005-in. per inch and varying in size from several grams to 3½ lb. How tooling, machining, design change and assembly costs are reduced is explained.

82. Rust Inhibitor
Nox-Rust Chemical Corp.—4-page illustrated circular "Protect Metal Parts" tells how Nox-Rust 310-AC removes fingerprints and deposits thin transparent film for protection against rust of metal parts in manufacture, storage or transit.

83. Research Facilities
Cook Research Laboratories—48-page illustrated brochure No. R-7 is descriptive of services, facilities and personnel of laboratories which are available to government agencies and private industry on contract basis.

84. Blueprint-Whiteprint Equipment
Paragon-Revolute Corp.—32-page illustrated catalog "Print-Making and Processing Equipment" covers line of blueprinting, diazo printing and reproduced tracing equipment for continuous yardage with automatic tracing separation and manual developer feed.

85. Vibration Absorbers
B. F. Goodrich Co.—4-page illustrated catalog section 7290 features step-by-step description of installation methods and describes Vibropad machine mounting which consists of 12-in. square rubber pad, tubes and snubbers. Pad supports feet or base of nearly any type of machinery, preventing it from transmitting jars, jolts or vibration.

86. Adhesive & Sealers
Minnesota Mining & Mfg. Co.—32-page illustrated booklet "3M Adhesives, Coatings and Sealers" tabulates properties of over 100 of these industrial materials. Also included is section covering 15 Coro-Gard protective coating systems and parts devoted to materials for shipbuilding, construction and oil industries.

87. Power Brushes
Osborn Mfg. Co.—4-page illustrated booklet describes Heli-master line of power brushes for cleaning and scrubbing prior to tin plating, Bonderizing or hot dip galvanizing and for finishing metallic and nonmetallic materials.

88. Rubber Compounds
Acushnet Process Co. — 32-page illustrated catalog No. 50 consists of three sections which include data on methods of molding, specifications and case histories on development of compounds for special applications; general properties of various rubber compounds; and plant facilities.

89. Hydraulic Components
Commercial Shearing & Stamping Co.—12-page illustrated catalog H-2 gives details of and suggested applications for oil hydraulic pumps, motors, valves and cylinders which are power operated for pressures up to 1500 psi. Wide range of sizes adapts these units to all types of equipment.

90. Direct Current Motors
Reliance Electric & Engineering Co.—12-page illustrated bulletin C-2001 offers users of ¾ to 1000-hp direct current motors design, construction, selection and other data on these units in dripproof, splashproof, totally enclosed, explosionproof, blower ventilated and gearmotors constructions. Heavy duty, constant and adjustable speed motors are described.

91. Check Valves
James-Pond-Clark—4-page illustrated bulletin "Circle Seal Precision Check Valves" gives design and application data on standard hydraulic and pneumatic check valves for working pressures to 3000 psi and temperatures from —65 to 280° F and on low pressure check valves for up to 100 psi in same temperature range. Special constructions can be furnished for temperatures to 500° F.

92. Motor Starters
Allis-Chalmers Mfg. Co.—12 and 8-page illustrated bulletins Nos. 14B6410A and 14B7303 present information on type H 2300 to 5000-v motor starters for squirrel-cage, wound rotor, synchronous and multispeed motors and type 256 air break contactor for applications requiring frequent starting, inching, reversing or dynamic braking, respectively.

93. Axial Flow Fans
Robinson Ventilating Co.—16-page illustrated bulletin 6001 on Tubeaxial fans lists capacities and static pressures of these units operating at various speeds. Dimensions and other information are given on direct and belt driven models in sizes ranging from 18 to 34 in.

94. Bearing Balls
Abbott Ball Co.—20-page illustrated bulletin contains information on bearing ball classifications and applications; selection, use and care of burnishing materials; practical barrel finishing; and lithographic plate graining.

FOR MORE INFORMATION
on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below

FIRST CLASS
PERMIT No. 36
(Sec 34.9 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Readers' Service Dept. CLEVELAND 13, OHIO

M. D. Numbers					
1	21	41	61	81	101
2	22	42	62	82	102
3	23	43	63	83	103
4	24	44	64	84	104
5	25	45	65	85	105
6	26	46	66	86	106
7	27	47	67	87	107
8	28	48	68	88	108
9	29	49	69	89	109
10	30	50	70	90	110
11	31	51	71	91	111
12	32	52	72	92	112
13	33	53	73	93	113
14	34	54	74	94	114
15	35	55	75	95	115
16	36	56	76	96	116
17	37	57	77	97	117
18	38	58	78	98	118
19	39	59	79	99	119
20	40	60	80	100	120

MACHINE DESIGN 12-50
Penton Building
Cleveland 13, Ohio

Please send literature or detailed information on subjects circled at left to—

NAME TITLE

COMPANY

MACHINES MANUFACTURED

ADDRESS

CITY AND STATE

This card MUST be completely filled out. Please TYPE or PRINT.

95. Plastics Cost Data

Monsanto Chemical Co., Plastics Div.—Pocket-size two-dial "Comparator" affords simple means for determining comparative costs of styrene and aluminum, phenolic and zinc or any contrast of plastic and other structural and fabricating materials. Reverse side of calculator gives condensed information on mechanical, thermal, electrical, optical and chemical properties of 12 leading plastics.

96. Motor-Generator Sets

General Electric Co.—8-page illustrated booklet GEA-5506 covers motor-generator sets ranging in size from 30 to 8000 kw. These machines are designed as source of direct current power for many industrial applications. Typical installations and features of synchronous motors and direct current generators are shown.

97. Hydraulic Controls

Hydraulic Equipment Co.—4-page illustrated bulletin 101 deals with Hydreco oil hydraulic control devices. Brief descriptions are included on gear type pumps, control valves, auxiliary valves, cylinder assemblies and combination pump, valve and tank units.

98. Wire Specialties

E. H. Tichener & Co.—6-page illustrated folder "Be Prepared" depicts typical wire forms, welded wire assemblies, wire and strip metal assemblies and light stampings which can be produced to specification by this company.

99. Stainless Steel Hardening

C. U. Scott & Sons—24-page illustrated pocket-size booklet explains Super Scottsonizing methods to be used in preparation of finished stainless steel parts for hardening. Parts hardened by this process retain their hardness at 1000° F.

100. Mach Number Chart

Square D Co., Kollsman Instrument Div.—"Kollsman Mach Number Chart" gives standard values for measurement of high speed in terms of Mach number, indicated air speed, differential pressure, altitude and absolute pressure. Pressure ratios, differential pressures and stagnation pressures for various Mach numbers are provided in tabular form.

101. Precious Metal Alloys

J. M. Ney Co.—20-page illustrated bulletin R-12 deals with applications of precious metal alloys for brushes, wipers, slip rings, commutator segments, resistance wire and noncorrosive wear-resistant parts in wide range of precision electrical equipment.

102. Hydraulic Actuator

Benjamin Lassman & Son—8-page illustrated bulletin No. 250 describes self-contained electrically-actuated Hydractor for applications requiring constant straight line push or pull. Models are available with standard 12-in. stroke to deliver working forces of 1000 to 4000 lb. Longer or shorter strokes can be supplied.

103. Corrosionproof Coating

Detrex Co.—4-page illustrated folder "Perm-Cote for Better Rustproofing" explains how this process creates heavy, uniform, insoluble phosphate coating on all iron and steel surfaces by chemical action. Any size or shape of part can be coated mechanically in baskets, tumbling barrels or on rack by immersing them in Perm-Cote solution.

104. Stainless Steels

Crucible Steel Company of America—32-page illustrated booklet "Making the Most of Stainless Steels in the Textile Industry" stresses advantages of various types of stainless steels for use in textile mills and points out that these types are readily weldable, free-machining and corrosion resistant. They can be bent and formed easily.

105. Industrial Fasteners

Industrial Fasteners Institute—16-page illustrated publication "Fasteners", volume six number four, delineates recent applications for improved industrial fasteners including bolts, nuts and rivets that possess ability to withstand high temperatures, vibration and other severe service conditions.

106. Motor Controls

Westinghouse Electric Corp.—20-page illustrated bulletin B-4677 demonstrates features of the new Life-Linestarter such as positive protection, ease of installation, simple maintenance, Bonderized finish, De-Ion arc quencher and flexibility of application. Five NEMA sizes cover range up to 100 hp and 600-v ac.

107. Miniature Speed Changers

Metron Instrument Co.—4-page illustrated bulletin No. 100 describes fixed-ratio type miniature speed changers in three different series for variety of applications. Standard ratios range from 10:9 to 531,440:1.

108. Welding Hose Couplers

Snap-Tite, Inc.—Illustrated bulletin and attached data and price sheets deal with Underwriters' Laboratories approved welding hose torch couplers that permit changing torches quickly and safely with simple snap on or off operation.

109. Rotary Gear Pumps

John S. Barnes Corp.—28-page illustrated loose-leaf catalog "Constant-flo Rotary Gear Pump" contains design, specification and application data on line of positive displacement rotary gear pumps for handling all types of fluids. These self-lubricating self-priming pumps are available in sizes to handle volumes ranging from 1/3 to 6 gpm.

110. Lubricating Systems

Trabon Engineering Corp.—12-page illustrated booklet "It Isn't Necessary to Lose Time Due to Bearing Failures. . ." explains how company's lubricating systems for oil and grease prevent many costly breakdowns.

111. Clutches & Transmissions

Light Inspection Car Works, V-Plex Clutch Div.—Two 2-page illustrated data sheets are descriptive of V-Plex special combination automatic transmission and clutch which enable engines or motors to come up to speed before load is applied and V-Plex clutches which are available with 2 to 2½-in. diameter pulleys for 1½ to 3-hp loads.

112. Standby Power Plants

D. W. Onan & Sons, Inc.—4-page pocket-size folder entitled "When Power's Off. . . . You're Safe" tells how standby generator designed for tractor belt drive can protect any business, factory or institution against property damage, production losses or danger to human life that might result from electric power failure.

113. Compression Fittings

Dresser Mfg. Div., Dresser Industries—12-page illustrated form No. 505 deals with flexible compression fittings that permit joining up to 2-in. pipe without threading. Twelve typical uses in case history form are cited to show wide application.

114. Production Parts

Ex-Cell-O Corp.—6-page illustrated bulletin No. 36151 depicts and describes company's facilities and services for volume production of miscellaneous production parts and sub-assemblies for clients' products.

115. Small Socket Screws

Bristol Co., Mill Supply Div.—6-page illustrated bulletin No. 881 deals with multiple-spline socket cap and set screws as small as No. 2 wire size.

116. Hydraulic Pumping Units

Denison Engineering Co.—4-page illustrated data sheet PU-2 describes two sizes of HydrOILic pumping units that can be used to provide from 400 to 2000-psi hydraulic pressures and from 3.5 to 11-gpm volumes for controlling power to HydrOILic power heads or other hydraulic devices within their pressure range.

117. Speed Reducers

Michigan Tool Co., Cone Drive Gears Div.—4-page engineering bulletin 789-50 gives basic general information on standard Cone-Drive speed reducers and gear sets ranging between 5:1 and 70:1 ratio and in capacities from 0.05 to 555 hp.

118. Packaged Cutoff Wheels

Chicago Wheel & Mfg. Co.—6-page illustrated folder "Moisture-free Chicago Cut-Off Wheels" explains how moistureproof packaging delivers wheels to user in factory-fresh condition to assure long life and fast cutting action.

119. Repulsion Motors

Miehle Printing Press & Mfg. Co., Star Kimble Motor Div.—2-page illustrated bulletin B-302 describes 1/6 to 3-hp continuous-duty single-phase repulsion motors. Illustrations of various models and of different speed and operating remote controls as well as data on current consumption at various speeds are included.

120. Aluminum Cable

Reynolds Metals Co. — 16-page illustrated booklet briefly describes operations at company's Listerhill, Alabama plant where alumina is processed into aluminum sheet, foil, cable, wire, rod, bar and other aluminum products. Production of steel-reinforced aluminum electric cable is explained and operations depicted.

M. D. Numbers					
1	21	41	61	81	101
2	22	42	62	82	102
3	23	43	63	83	103
4	24	44	64	84	104
5	25	45	65	85	105
6	26	46	66	86	106
7	27	47	67	87	107
8	28	48	68	88	108
9	29	49	69	89	109
10	30	50	70	90	110
11	31	51	71	91	111
12	32	52	72	92	112
13	33	53	73	93	113
14	34	54	74	94	114
15	35	55	75	95	115
16	36	56	76	96	116
17	37	57	77	97	117
18	38	58	78	98	118
19	39	59	79	99	119
20	40	60	80	100	120

MACHINE DESIGN 12-50
Penton Building
Cleveland 13, Ohio

Please send literature or detailed information on subjects circled at left to—

NAME TITLE

COMPANY

MACHINES MANUFACTURED

ADDRESS

CITY AND STATE

This card MUST be completely filled out. Please TYPE or PRINT.

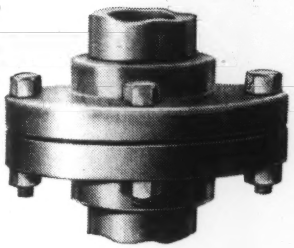
FIRST CLASS
PERMIT No. 36
(Sec. 34.9 P.L.&R.)
Cleveland, Ohio

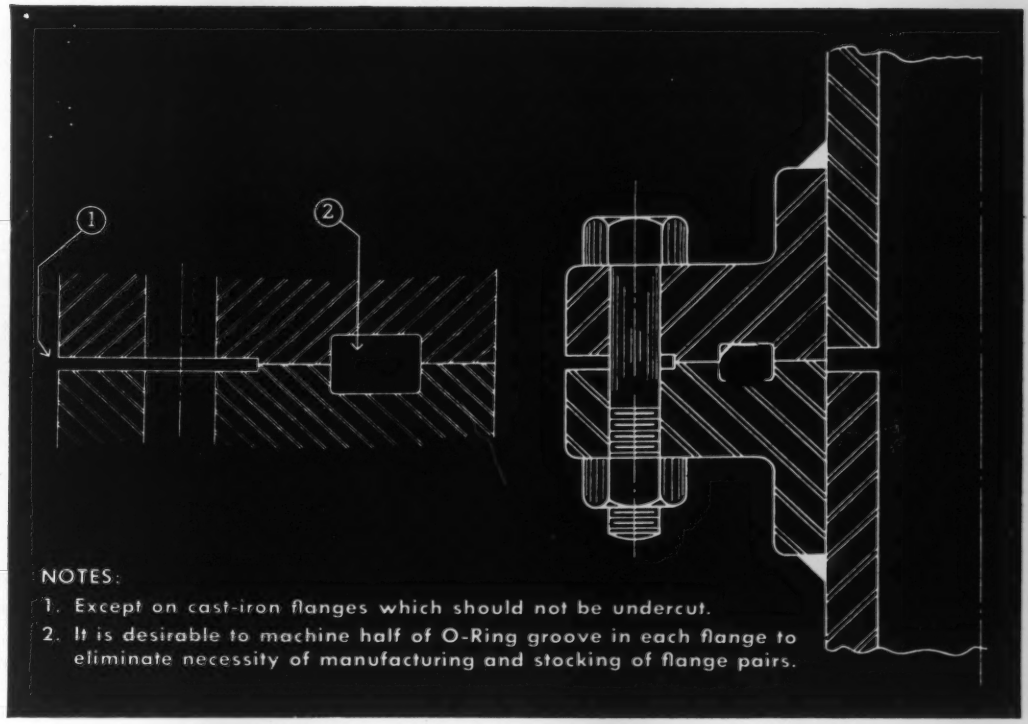
BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
CLEVELAND 13, OHIO

Readers' Service Dept.





TIP...

FOR THE DESIGNER

Eliminate Guesswork! Bolt Metal-to-Metal with...

LINEAR PRECISION MOULDED "O" RINGS

You get a perfect seal with only metal-to-metal contact between flanges when you use a Linear "O" Ring Gasket. There's no more need for straining at bolts . . . and no more need for periodic checking or tightening.

Linear "O" Rings are easily installed, without special assembly tools or gasket paste. They maintain a positive seal in spite of vibration. They cannot be unduly squeezed or damaged by over-tightening. They enable a reduction in the number of bolts required for a leak-proof seal. They eliminate expensive shut-downs and repairs created by inopportune gasket failure. And, they take the guesswork out of the effectiveness of your flanged connections . . . help you standardize on one simple, efficient, maintenance-free method.

Linear "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and silastics . . . are available in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes for special uses. For specific help with *your* sealing problem . . . CALL LINEAR.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

UNFAILING PERFORMANCE GUARANTEED

HOLO-KROME

Completely Cold Forged

SOCKET HEAD

CAP SCREWS

CONTROLLED STRENGTH—Completely cold forged from special analysis alloy steel. Scientifically heat treated to develop the utmost in all physical properties.

CONTROLLED ACCURACY—Heads are concentric with body. True hexagon sockets with controlled uniform depth and smooth, taperless walls.

CONTROLLED INSPECTION—Holo-Krome's own Physical and Chemical Laboratories control production from raw materials to final inspection. All H-K products are given final, individual inspection for Class 3 Thread Fit; Pitch; Lead and appearance.

Available through Authorized Holo-Krome Distributors

HOLO-KROME

Completely Cold Forged Socket Screw Products

THE HOLO-KROME SCREW CORP., HARTFORD 10, CONN.

503

Which Design

answers your most important problems about micronic filtration?

WHICH

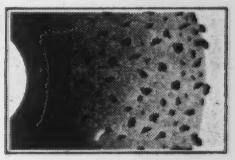
is the only micronic filter that works by a positive mechanical principle?

Cuno MICRO-KLEAN cartridge consists of tiny fibres distributed under scientific control and resinous impregnated and polymerized to prevent softening, swelling, hardening, shrinking, rupture or channelling. Solids are simply entrapped in the interstices—no other means is utilized. Densities: 10, 25, 50 microns. Wide range of fluids, flow rates and capacities (from a few to more than 800 gpm). Single or multiple cartridge units.

WHICH FILTER

needs the least amount of room?

Cuno MICRO-KLEAN cartridge is utterly simple. It's all filter, no structural components. This means less space needed—and makes *full-flow filtration* practical for either external or built-in applications.



WHICH FILTER

is guaranteed for specific performance?

Felting of fibres is accurately controlled for various densities . . . so that a Cuno MICRO-KLEAN of a given density will positively remove 100% of all solids for which it is rated, plus a large percentage down to 1 micron.

Your Customers will like . . .

Longer life—Exclusive "graded density in depth" permits smaller particles to penetrate to varying depths—doubles dirt-holding capacity.

Low pressure drop.

Changing cartridge is quick—and clean.

No Fluid Is Better Than Its Filtration

CUNO

Complete Line

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC Micro-Klean • DISC-TYPE Auto-Klean
WIRE-WOUND Flo-Klean

Mail this Coupon . . . for FREE Catalogs

Make Sure to Investigate **MICRO-KLEAN *First***

- ☐ Lubricating Oil
- ☐ Hydraulic Oil
- ☐ Water and Water Solutions
- ☐ Compressed Air
- ☐ Fuel Oil
- ☐ Acids

CUNO ENGINEERING CORPORATION
2014 South Vine St., Meriden, Conn.

Please send information on Cuno MICRO-KLEAN for services checked.

Name.....Title.....

Company.....

Address.....

City.....State.....

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

Reprints from this or other Logbook pages are available for your files. Request them from our Redwood City, California office

Valve seat grinder poses two distinct oil sealing problems

Two unusual shaft sealing problems are present in the rotary valve seat grinder for large gasoline and diesel engines (Fig. 1). Rotary speeds from 300 to 12,000 rpm, shaft whip, reciprocating action and extreme external abrasive conditions require oil seals of unusual dependability.

In the sectional drawing (Fig. 1), the main shaft driving the abrasive wheel rotates at 12,000 rpm. This shaft also engages a secondary worm gear to rotate the entire grinder around the periphery of the valve seat. National 50,000-S Syntech (Fig. 2) seals, spring-loaded, single wipe units are installed just inside the pre-loaded ball

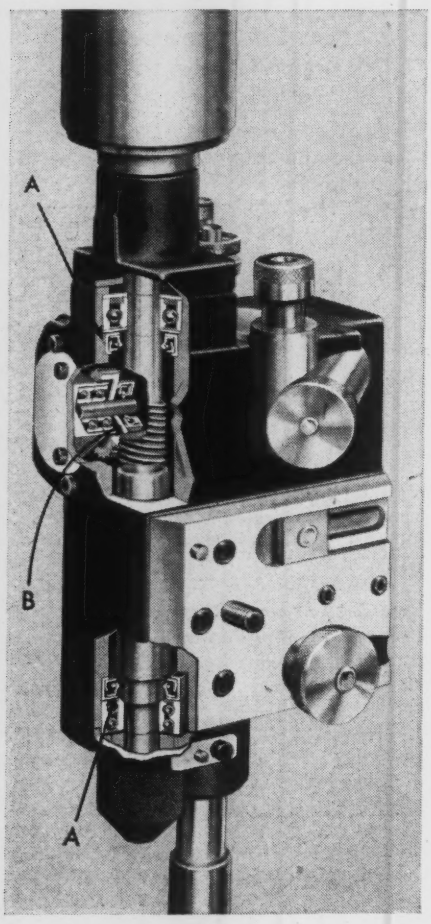


Figure 1

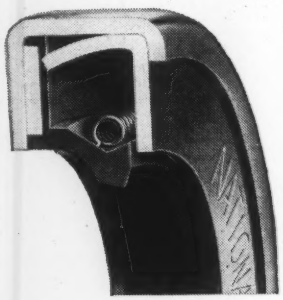


Figure 2

bearings (A) on the main shaft and outside the conventional bearing (B) on the horizontal shaft (in Fig. 1). These seals retain a light lubricating oil in the open double row bearing (B) and the high-speed worm gear. Even though flooding is encountered, zero leakage performance must be achieved to prevent flooding of the grinding wheel. The high speed and angle thrust on this spindle result in shaft whip, which demands flexibility in the oil sealing members. National Syntech* oil seals are ideal for this application, because their inherent flexibility and *carefully* designed flex section provide effective sealing under eccentricities up to .025 indicator reading. The minimum-contact, carefully tensioned sealing lip insures minimum drag and dependable sealing even under continued operation at high speeds.

Figure 3

The section (Fig. 4) is of a wheel dressing attachment. Here shaft action is reciprocative and extreme abrasive conditions are present since the assembly is continually exposed to fine abrasive dust from the grinding wheel. Two sturdy National Syntech 340,000 series (Fig. 3) are installed here. The seals are mounted with lips facing outward (C) and serve as dust excluders. Effectiveness of the seals is attested by the fact that with hundreds of grinders in operation, no replacement has yet been required due to scored shaft surfaces or abrasive leakage.

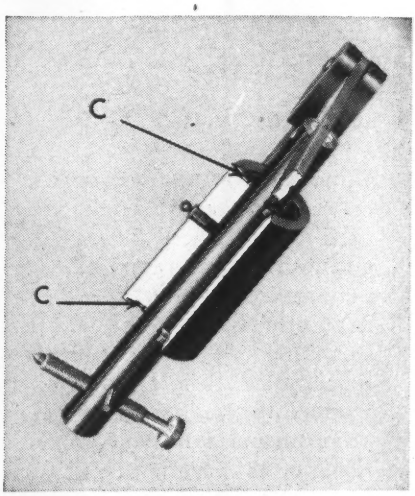


Figure 4

In many cases such as the above, sealing problems can be solved at considerable savings by using stock National Oil Seal designs. In other applications, special designs may be necessary. In either event, National Oil Seal engineers are ready to assist you.

"Let Your Decision be Based on Precision"

NATIONAL
OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2169

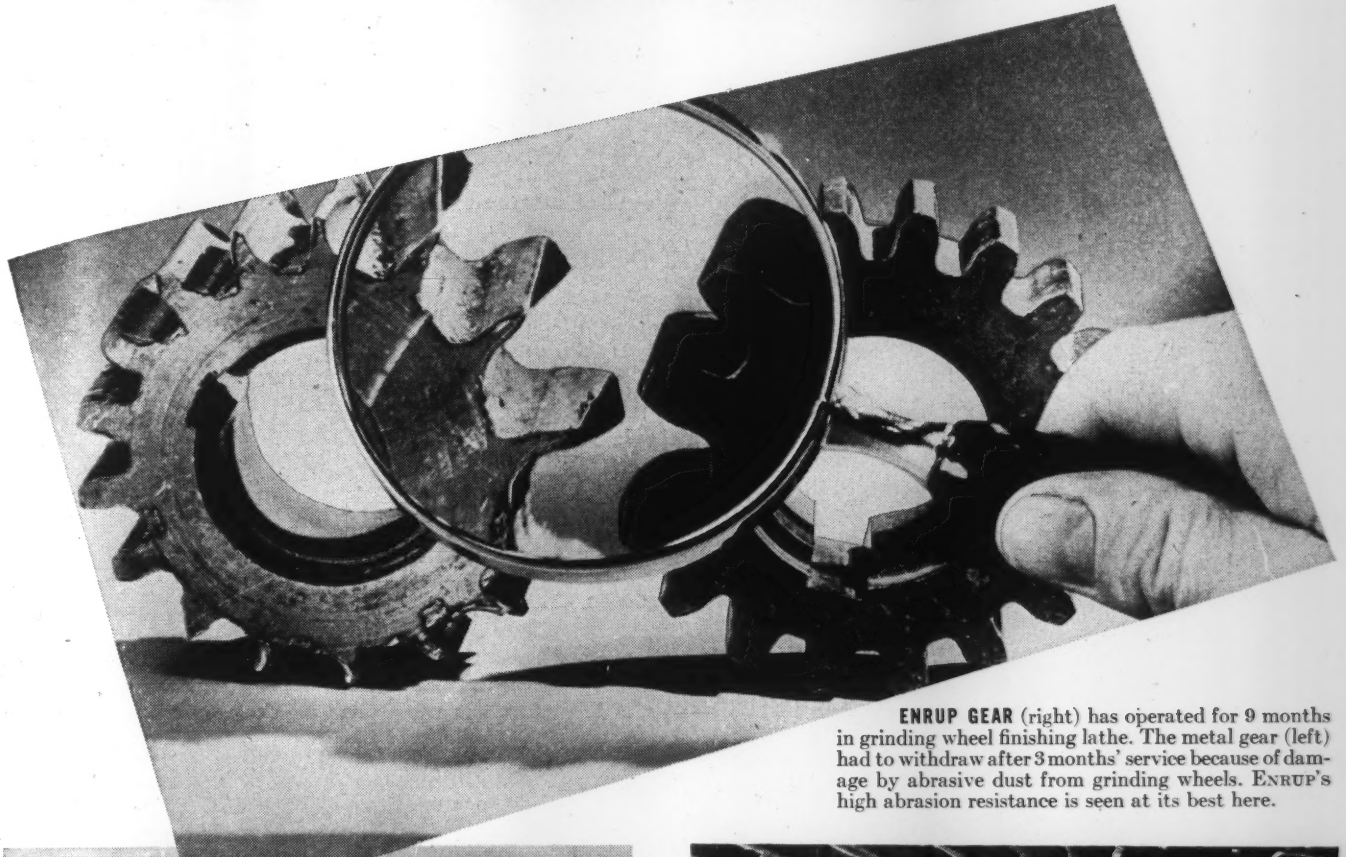
*Trade Mark Registered

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

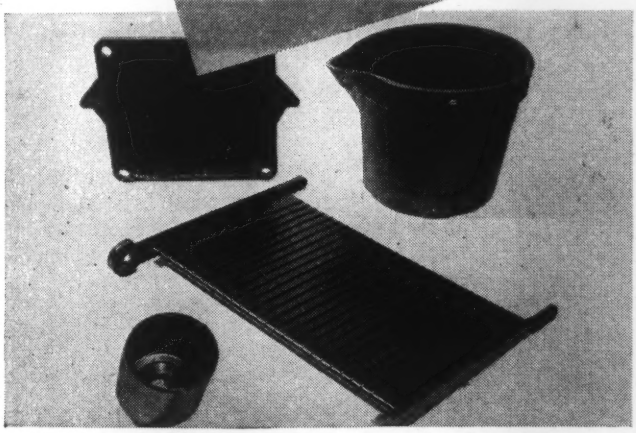
BUFFALO, N. Y. . . . *Room 1194, Prudential Bldg., Mohawk 9222*
CHICAGO, ILL. . . . . *Room 2014 Field Building, Central 6-8663*
CLEVELAND, OHIO *210 Heights Rockefeller Bldg., Yellowstone 2720*
DALLAS, TEXAS . . . *30½ Highland Park Village, Justin 8-8453*
DETROIT, MICH. . . . *Room 1026 Fisher Building, Trinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., Topaz 2-8166*
MILWAUKEE, WIS. . . . *647 West Virginia St., Marquette 8-8986*
NEW YORK CITY, N. Y. . . *122 East 42nd Street, Lexington 2-8260*
PHILADELPHIA, PA. . *401 North Broad Street, Bell-Walnut 2-6997*
REDWOOD CITY, CALIF. . . *Broadway and National, Emerson 6-3861*
WEST SPRINGFIELD, MASS. . . *1025 Elm Street, Springfield 2-1881*
SYRACUSE, N. Y. . . . . *P. O. Box 1224, Baldwinsville 662*
WICHITA, KANSAS . . . . *504 East Third Street, Wichita 2-6971*

ONE GEAR BIT THE DUST, ONE DIDN'T

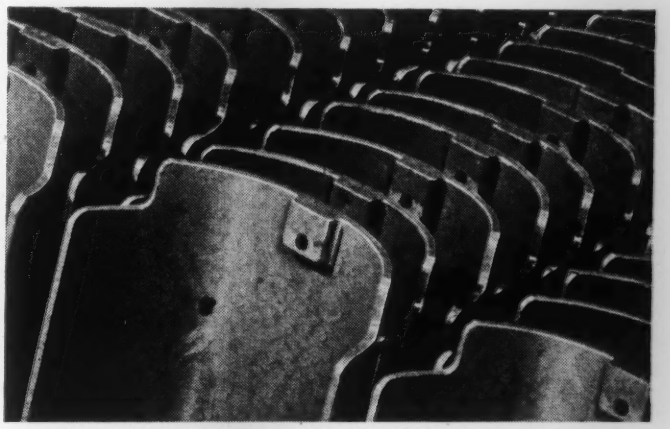
Abrasive dust makes short work of metal gear, has no effect on gear made of U. S. Rubber's new thermosetting plastic ENRUP



ENRUP GEAR (right) has operated for 9 months in grinding wheel finishing lathe. The metal gear (left) had to withdraw after 3 months' service because of damage by abrasive dust from grinding wheels. ENRUP's high abrasion resistance is seen at its best here.



FILTER PRESS PLATE, upper left, and chemical bucket, right, are molded from ENRUP replacing hard rubber because of toughness, heat and chemical resistance. Center is photostat separator plate, once made of hard rubber, now made of ENRUP because of superior toughness and high impact strength. Lower left is lap roll used in the textile industry. Once made of laminated phenolic, it is now molded out of ENRUP, cutting cost by 50%.



THESE COVERS for electroplating barrels were molded in one piece from ENRUP. Previous practice was to fabricate cover in sections from a thermoplastic material, then cement sections together. Molding cost has been cut more than 25 per cent. ENRUP can be punched, sawed, sanded, nailed, bolted, and machined. There is almost no end to its versatility.

ENRUP IS FABRICATED AND MOLDED ENTIRELY BY U. S. RUBBER ENGINEERS. Leading manufacturers select ENRUP to help make their products an outstanding success. ENRUP is about half the weight of aluminum, and is available in varying degrees of flexibility, ranging between that of elastic soft rubber on one hand, and hard rubber on the other. For more details on this remarkable plastic write to:

A DEVELOPMENT OF

U.S.RUBBER

SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Looking for trouble before it starts...

with an MB VIBRATION EXCITER

One of the many instruments produced by the Sperry Gyroscope Company is here undergoing a "shake test" on the MB model S-3 Vibration Exciter. Such vibration testing contributes to the dependability in service for which Sperry instruments are noted. The instrument is fastened to the shake table of the exciter, which is controlled from panel. Amplitude, velocity and acceleration are being read directly on an MB Vibration Meter.

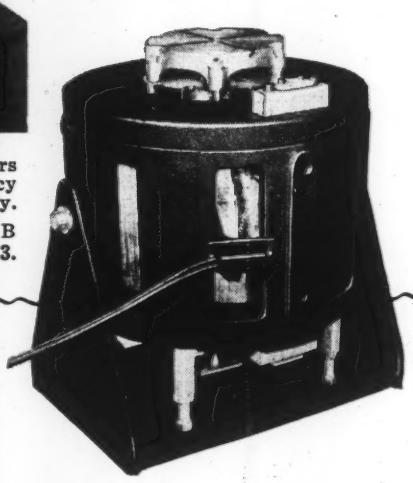
WHEN PRODUCTS GIVE unexpected trouble in service, you'll find too often that it's due to vibration.

Foresighted concerns take no chances with this enemy of equipment life. At Sperry Gyroscope Company, possible troubles due to vibration are ferreted out in the laboratory. By means of an MB Vibration Exciter, which has quick, easy adjustments for force and frequency, instruments are checked for vibratory response—for ability to resist fatigue. Result: Trouble is eliminated in the design stage, *before* it starts.

This shaker is adaptable to countless situations. You can test miniature electrical assemblies to mammoth wing structures; filaments to heavy axle shafts. In one of its jobs—fatigue testing—the shaker reproduces vibratory effect of years within hours. One company, for example, reduced the time of spot-checking bellows to 10 minutes—a job which formerly took 12 hours per unit!

Location of noise sources . . . actual observation of the motions of vibrations . . . study of damping characteristics of materials . . . these are but a few other important jobs where an MB Exciter pays off.

Models which deliver forces of 5, 25, 50, 100, 200, 300 pounds and higher are now available—all electromagnetic. We'd like to explain the technique of their use in detail, show you how to use one on your own problems. Write us without obligation.



The Model S3 Vibration Exciter illustrated delivers peak force of 200 pounds. Operates in frequency range of 3 to 500 C.P.S. Has rotating power supply.

Write us for more detailed information on MB Vibration Exciters, and ask for **bulletin 410 M3.**

THE MB MANUFACTURING COMPANY, Inc.

1060 State Street, New Haven 11, Conn.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION . . . TO MEASURE IT . . . TO REPRODUCE IT

TO INSURE PROMPT DELIVERIES . . .

"STANDARD" RECOMMENDS *STANDARDS*

You can depend on prompt deliveries of UNBRAKO Products when you use *standard sizes.*

For, despite shortages, stepped-up demand and other problems of the emergency, we've been able to keep full stocks of UNBRAKO "*standards*" on our dealers' shelves—ready for immediate delivery.

And that's not all . . . Every time you use a *standard size* UNBRAKO it represents a substantial saving over the cost of a "special."

Be sure you have our latest catalog of UNBRAKO *standard* products. Send for your copy of Bulletin 643-R *today.*

Knurled Head Socket Cap Screws
Flat Head Socket Cap Screws
Self-Locking Socket Set Screws

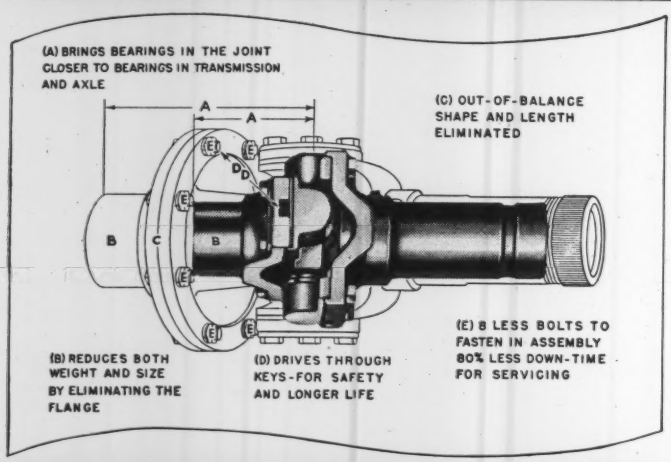
SOCKET UNBRAKO SCREWS

Knurled Head Shoulder Screws
Precision-Ground Dowel Pins
Fully-Formed Pressure Plugs

SPS STANDARD PRESSED STEEL CO.

JENKINTOWN 18, PENNSYLVANIA

You Are PAYING For MECHANICS JOINTS



Why Not Give YOUR Truck MECHANICS Advantages?

Every time you use a joint that requires unnecessary attachments and extra assembly time and labor, you are paying for MECHANICS Roller Bearing UNIVERSAL JOINTS advantages—but are not getting the benefit of them. And you are forcing your truck to carry unnecessary DEADWEIGHT that should be devoted to PAYLOAD. Let our engineers explain how MECHANICS design advantages will help give your truck competitive advantages.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner
2032 Harrison Avenue
Rockford, Illinois

MECHANICS
Roller Bearing
UNIVERSAL JOINTS
For Cars · Trucks · Busses and Industrial Equipment

Announcing

ASCO "MIDGET" SIZE TWO-WAY AND THREE-WAY SOLENOID VALVES

This is the new small ASCO Two-Way Solenoid Valve . . . only 2-13/16" from the top of the solenoid housing to the bottom of the valve body. The Three-Way Valve or the Two-Way Valve designed for Normal Open Operation is only slightly larger, being only 3-5/16" from top to bottom. (The latter valve is the lower picture.)

These Midget Two-Way and Three-Way Valves have many applications in the control field because of their compactness, sturdiness and efficiency. The Two-Way Valve comes in two pipe sizes: 1/8" and 1/4" Normally Closed (closed when de-energized) and 1/8" Normally Open (open when de-energized). The Three-Way Valve comes in one pipe size only: 1/8". Both are standard in brass or stainless steel. Permissible pressures: Two-Way Valves up to 300 lbs./sq. in. (AC) and up to 250 lbs./sq. in. (DC); Three-Way Valves up to 125 lbs./sq. in. (AC) and up to 50 lbs./sq. in. (DC). Adjustable Main Flow and By-Pass Flow available for Two-Way Valves. Twenty-Four inch (24") leads.

If you have been looking for a really small and really efficient solenoid valve, one of these two ASCO Midget Valves may be just what you need. We'll be glad to send you complete information (Bulletins 8262 and 8314) but in writing will you tell us something about your requirements?

These valves will be exhibited in Booth 550-551 at the New York Power Show, November 27th to December 2nd.

ASCO Solenoid VALVES

When in need of Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Specialized Electromagnetic Controls, come to us.

Automatic Switch Co.
387 LAKESIDE AVENUE · ORANGE, NEW JERSEY

BOOKS FOR NEW PRODUCTION IDEAS

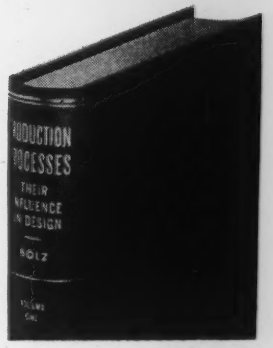
PLASTICS IN ENGINEERING By John Delmonte. Here's a brand new "how-to-do-it" book of technical data that will help you determine the RIGHT plastic material, the RIGHT mold design and the RIGHT fabricating technique to solve your plastics problem. PLASTICS IN ENGINEERING puts scores of up-to-the-minute facts about plastics right at your fingertips: How strong various plastics are—for what uses they are best suited —how to design plastic parts—how these remarkable synthetic materials are molded, extruded, laminated, cast—how much heat they will stand—how to guard against failure—how to machine plastics—and other vital factors that are so essential to satisfactory plastics performance. Contains 656 pages . . . 168 illustrations . . . 81 tables. Third edition. *Price $10.*

MECHANICAL SPRINGS By A. M. Wahl. This book is filled with the kind of information that will enable you to make preliminary calculations on the design of all types of springs: Compression . . . tension . . . torsion . . . and spiral. Practical formulas for design, plus complete, authoritative information on spring application make it a valuable addition to your handbook and engineering data files. This book of 435 pages puts spring design on a rational basis. You will find that no matter what your problem . . . working stress . . . fatigue . . . buckling . . . or just plain maximum efficiency . . . that the use of "Mechanical Springs" will reduce your number of spring failures due to "guesswork" as well as save you time and materials. *Price $6.*

GATES & RISERS FOR CASTINGS By Pat Dwyer. This book by the engineering editor of The FOUNDRY magazine, has no equal as a source of information on how to eliminate casting defects. Foundrymen will find that it thoroughly covers all the various problems that arise in the design and use of gates and risers. Detailed examples of gates and risers for practically all types of ferrous and non-ferrous castings are described and illustrated. It gives you practical methods of gating gray iron, steel, malleable iron, aluminum, brass and bronze castings. Practically every problem that you can encounter is covered in an easy-to-read text that is accompanied by detailed drawings. This brand new, third edition, contains 384 pages, 247 illustrations, 31 chapters, and is fully cross-indexed. *Price $6.*

Published by the Penton Publishing Company, 1213 West Third St., Cleveland 13, Ohio.

How Much Guesswork *Are You Putting into Your Designs?*



"PRODUCTION PROCESSES, Their Influence on Design," by Roger W. Bolz, is a new working tool that will help you take the "guesswork" out of your designs. It's your answer to the problem of how to design specifically for production. It puts at your instant command the facts and figures you need to know about the various production processes . . . and how they influence your designs.

Covers 36 Different Processes

PRODUCTION PROCESSES is packed from cover to cover with facts and figures on 36 different processes. When you want to design a new part or improve a present design, you will find in its pages every fact that has a bearing on your work. When you want to know the character, scope, capabilities, or limitations of a process—you will find it in this book, simply and clearly explained.

PRODUCTION PROCESSES thoroughly covers all the different design factors involved in Metal Removal, Forming, Working, Forging and Deposition. It gives you down to earth data on such factors as how to select materials . . . the surface finishes produced by various processes . . . and the practical tolerances which can be held while using various processes.

Answers These Typical Questions

What production factors should be considered in design? . . . What pitfalls should be avoided in designing? . . . What level of precision can be maintained in mass production without exceeding normal costs? . . . What are the minimum production levels below which costs may be excessive? . . . When are the various production processes used?

Practical Production Approach

PRODUCTION PROCESSES will be invaluable to you and the men working with you because it presents 658 pages of basic production process information in concise, easy-reference form, complete with over 650 illustrations, tables, graphs and charts. It's quickly read—quickly comprehended.

Free Trial Offer

Why not decide for yourself how useful PRODUCTION PROCESSES, or any of the books listed on this page, can be to you? Just fill in the certificate and mail it today. It will bring you a copy of the book you want to see by return mail. Examine it FREE for ten days—at the end of that time send us the purchase price of the book, plus a few cents for postage—or return the book absolutely without obligation. Just fill-in and mail the free examination certificate now.

FREE TRIAL CERTIFICATE

THE PENTON PUBLISHING COMPANY, Book Department MD-11
1213 West Third Street, Cleveland 13, Ohio

Please send the following books I have checked:

- ☐ On ten days trial for free examination, following which I will pay for the book at the regular purchase price, plus a few cents for postage, or return it in good condition.
- ☐ Remittance enclosed* in which case the book will be sent postpaid.
- ☐ C.O.D.

- ☐ Production Processes, $10.
- ☐ Mechanical Springs, $6.
- ☐ Plastics in Engineering, $10.
- ☐ Gates and Risers, $6.

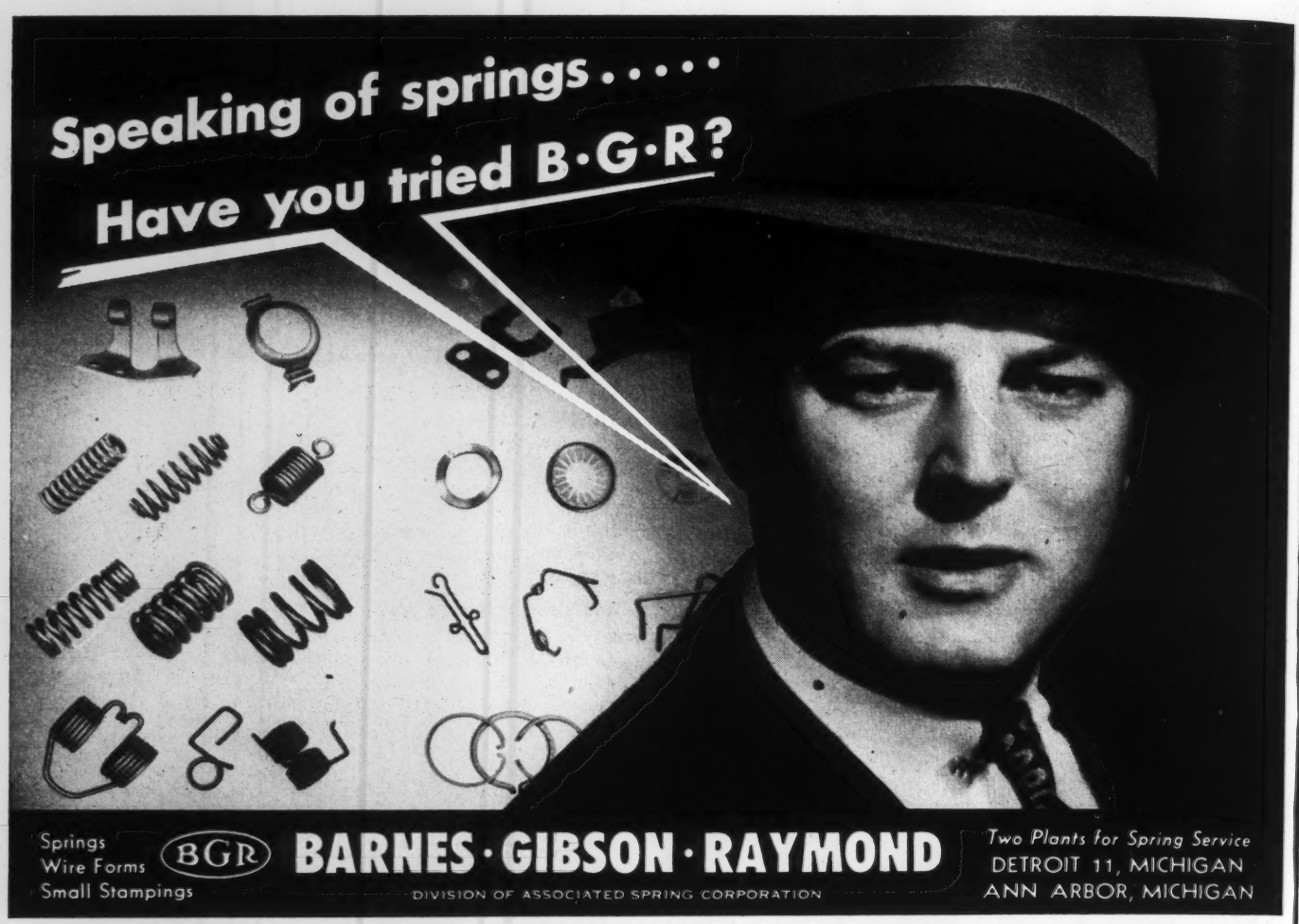
Signed _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

** Please add 3% to cover state sales tax on orders for delivery in Ohio.*



Springs
Wire Forms
Small Stampings

BGR **BARNES · GIBSON · RAYMOND**

DIVISION OF ASSOCIATED SPRING CORPORATION

Two Plants for Spring Service
DETROIT 11, MICHIGAN
ANN ARBOR, MICHIGAN

FOR YOUR 7 TO 13 H.P. POWER JOBS

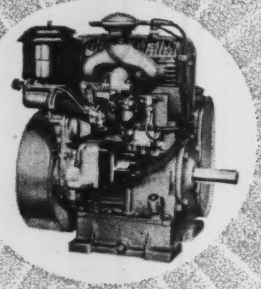
Two-Cylinder

WISCONSIN

Heavy-Duty

Air-Cooled

ENGINES



Models TE and TF standard engine illustrated; also available as complete Power Units with Clutch Take-Off Assembly or with Clutch Reduction Assembly.

Designed and built to traditional Wisconsin Motor heavy-duty service standards, Models TE-TF Air-Cooled 2-cylinder engines provide ideal power either as component units on original equipment, or as stationary or portable general purpose power within the 7 to 13 hp. bracket.

The Model TE delivers from 7.2 to 11.2 hp. and the Model TF turns up 8.6 to 13.3 hp. within a 1400 R.P.M. to 2600 R.P.M. speed range. Features include: tapered roller bearings at BOTH ends of the heat-treated, drop-forged crankshaft; high tension rotary-type OUTSIDE Magneto with impulse coupling; oil bath air cleaner; ¾" standard float feed carburetor; positive lubrication by Pump with individual oil stream to each rod . . . *plus* dependable air-cooling at all temperatures from sub-zero to 140°F.

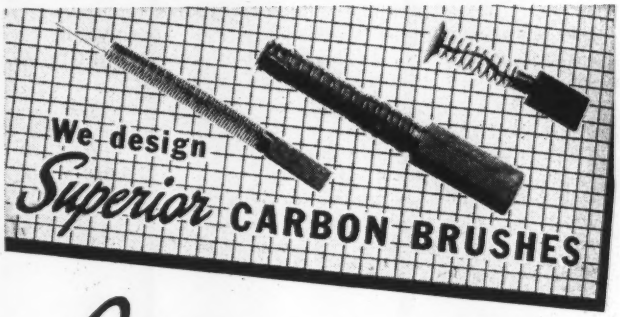
For "Most H.P. Hours" of on-the-job power service, specify Wisconsin Air-Cooled Engines . . . single cylinder, 2-cylinder and 4-cylinder, in a complete power range from 3 to 30 hp.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46 WISCONSIN



To *Overcome* Your Problems

***due to:* SILICON VAPORS • RADIO INTERFERENCE HIGH ALTITUDE OPERATION • EXCESSIVE CURRENT DENSITY • HIGH PERIPHERAL SPEEDS • EXCESSIVE ARMATURE REACTION**

You say (and we agree), "But *our* problem is different". *Every* electrical problem is different. Our service to you is based upon a recognition of that fact. Therefore we study *your* particular problem until we arrive at the *one best answer.* No obligation, sir, but please give us all the details the first time.

Write for Bulletin D-12.

SUPERIOR CARBON PRODUCTS, Inc.
9116 GEORGE AVENUE, CLEVELAND 5, OHIO

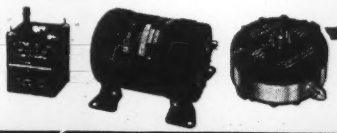
Since 1919 **SUPERIOR** CARBON BRUSHES

LOW or HIGH PRESSURE

High pressure or low, there is a Giannini precision pressure transmitter that meets your requirements for remote indication, recording or control.

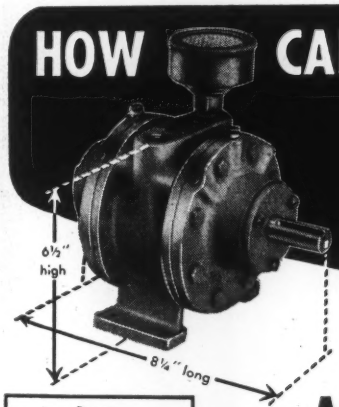
From less than 1 up to 10,000 psi, with various types of resistance and inductive output values, Giannini precision pressure transmitters are designed to withstand extremes of acceleration, temperature, vibration, while at the same time retaining their accuracy and their fast response characteristics. "They are standard with the Leaders." Write for booklet.

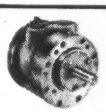
G. M. Giannini & Co., Inc., Pasadena 1, California



giannini

HOW CAN YOU USE this GAST 3 h.p. ROTARY AIR MOTOR?





This style for flange mounting.

On your present products — or those now being designed — you may gain outstanding advantages by using this *larger* GAST No. 8 Air Motor.

Built on the famous GAST rotary-vane principle, the No. 8 delivers variable-speed power with simple valve control. It's explosion proof . . . it can't burn out from overloads . . . and it delivers a smooth 3 h.p. at 1500 r.p.m. *with a weight of only 25 pounds!*

Investigate this unique, compact motor now — it may provide unusual advantages for your application.

see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

"AIR MAY BE YOUR ANSWER!"

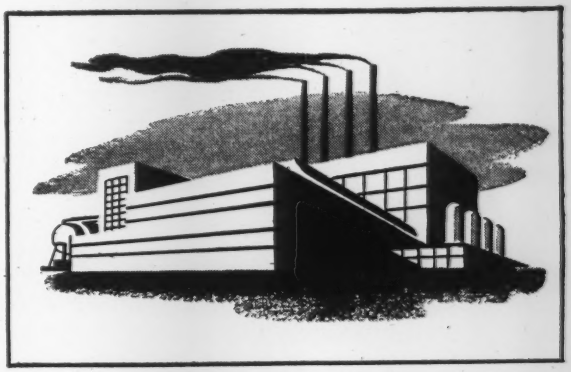
Write for new bulletin AM-8 and complete specifications — today!

GAST ROTARY AIR MOTORS · COMPRESSORS · VACUUM PUMPS
(To 3 H.P.) (To 30 Lbs.) (To 28 Inches)
GAST MANUFACTURING CORP., 107 Hinkley St., Benton Harbor, Mich.

Bendix-Skinner

ORIGINATOR OF **MICRONIC** FILTRATION

the Finest Way to Make Liquids Come Clean



Nine times out of ten ***Bendix-Skinner*** filters will supply the "finest" answer to your problem. No magic—just the simple fact that ***Bendix-Skinner*** has developed entirely new and exclusive filtering techniques in twenty years of tackling the tough jobs. We'll welcome an opportunity to prove it. An inquiry costs you nothing and may save you much.

***Over 350 Models** providing filtration from ½ micron (.000019") upwards at flow rates from 1 to 5000 g.p.m.*

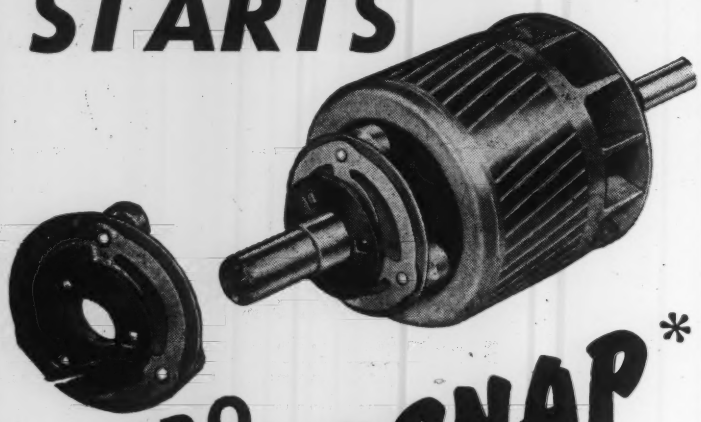
Disc-type Ribbon-type Pleated-type

SKINNER PURIFIERS DIVISION OF
1503 TROMBLY AVENUE,
DETROIT 11, MICHIGAN

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Ave., N. Y. 11, N. Y.

POSITIVE SNAPACTION FOR 750,000 STARTS



TORQ SYNCROSNAP*

THE POSITIVE CHATTERLESS STARTING SWITCH

FOR EVERY SPLIT PHASE and CAPACITOR TYPE, SINGLE PHASE FHP MOTOR

What Can These Advantages Mean To You?

1. Simple—only one moving part.
2. Positive snap action—absolutely no flutter or chatter.
3. No wearing or frictional parts.
4. No coil nor leaf springs, no toggle action, no elaborate assemblies.
5. Action is positive and uniform, regardless of load condition and acceleration rate of motor.
6. Assures many times the normal life of contacts, starting windings and capacitors.

SYNCROSNAP* is now available in production quantities for motors from 1/8 to 1/2 HP; shaft diameters 5/8 to 13/16 inches; speeds from 900 to 3600 RPM. Other models are being developed, suitable for varying shaft diameters, larger and smaller motors and for varying dimensional limitations of rotor diameters and overall shaft lengths.

Get full information about TORQ SYNCROSNAP* winding protection for your own motors. Phone, wire or write today.

* Patent Pending

TORQ ELECTRIC CORPORATION

1075 INTERSTATE ST. BEDFORD, OHIO

Micro Ball Bearings

Now..

a NEW FLANGED BEARING

another Micro First!

For easier mounting and assembly and manufacturing economies. Permits substituting punched sheet-metal housings for expensive, precision-machined castings.

No. FR1-5: 3/32" bore x 5/16" minor O.D. x 23/64" flanged diameter and 7/64" width with exclusive MICRO *ground* O.D. and outer raceway.

In both Conrad (retainer) and full-race designs.

Write today for data sheet Technical Bulletin No. 50.

New Hampshire *Micro* Ball Bearings, Inc.

12 Micro Circle Peterborough, New Hampshire

The GROUND Miniature Bearing

Full-speed ahead, America . . . and Viking is all set to go. Distributors are strategically located in every important production center of the nation—Sales and Service Offices blanket the country.

With the most complete line of rotary pumps in the world, Viking is prepared to serve you with the right answer to your pumping problem.

SALES and ENGINEERING SERVICE

S STOCK

● MAJOR JOBBING Representatives

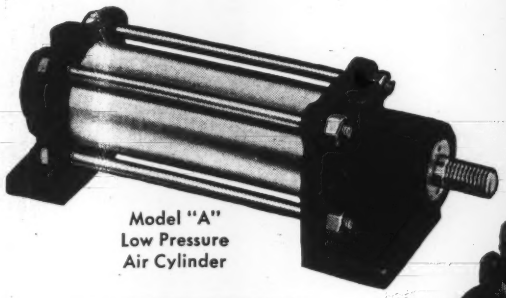
VIKING AN HONORED NAME IN PUMPING

For a copy of free bulletin 51SH (Rotary pumps from 2/3 to 1050 gpm) and the name of your nearest distributor, write today. No obligation.

See Our Catalog in SWEETS

Viking PUMP COMPANY

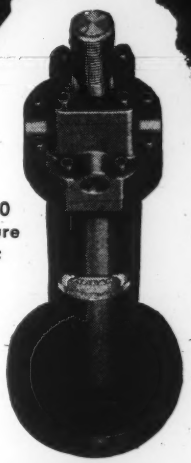
Cedar Falls, Iowa



Model "A"
Low Pressure
Air Cylinder

Dependable Cylinder Power by NOPAK

For further information and data on NOPAK Cylinders and Valves, refer to Sweet's File for Product Designers, or write for Bulletin SW-1.

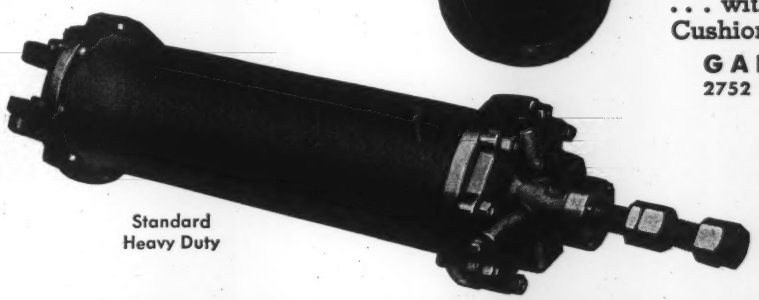


Series 1500
High Pressure
Hydraulic

For simplified machine movements . . . for pulling, pushing, lifting, clamping . . . with power range from Low Pressure Air to High Pressure Hydraulic . . . there's a NOPAK Cylinder to meet your needs.

NOPAK Cylinders are available in 4 different classes of construction . . . to meet varied service requirements and to accommodate line pressures from 50 to 2000 P.S.I. . . . in 6 Standard Mountings . . . with or without Adjustable or Self-Regulating Cushions...and a choice of Piston Assembly Types.

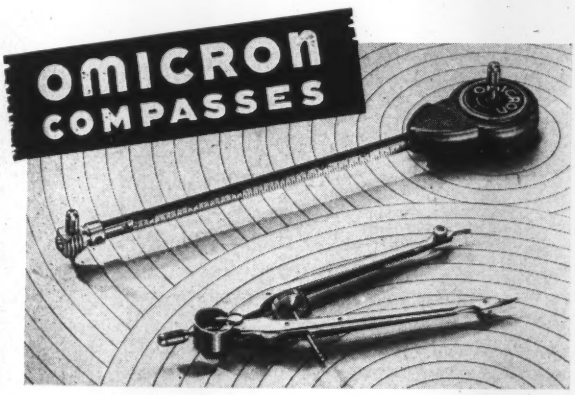
GALLAND-HENNING MFG. CO.
2752 SOUTH 31st ST. • MILWAUKEE 46, WIS.
Representatives in Principal Cities



Standard
Heavy Duty

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

A-5841-½H-A



Two Products of American Ingenuity

THE BEAM COMPASSES 72 Inches Radius Capacity in the palm of your hand. Fast, Accurate, Delightful to use. Only one hand required to guide the scriber pin. The housing swings freely around the center pin. Spring loaded lever holds beam in locked position. Beam on edge assures parallel disposition between center pin and scriber.

THE BOW COMPASSES 6 Inches Radius Capacity. Quick change, Selflocking, Slow Motion Adjustment in one mechanism of stunning simplicity. No threads, only a smooth rod and a trigger! The U shaped steel legs, heavily chromium plated, account for light weight and perfect balance.

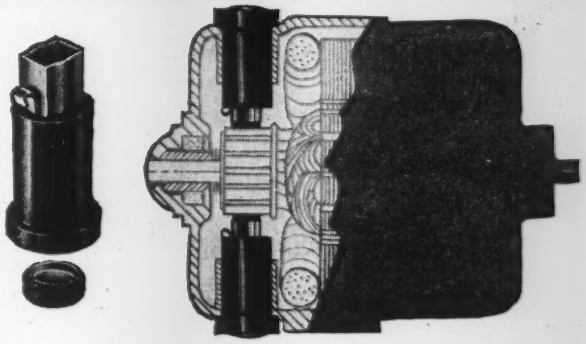
Ask your Dealer or write us for more Details

Omicron Co. Dept. M2 Box 907 Glendale, Calif.

PHOENIX BRUSH HOLDERS

FOR FRACTIONAL HORSEPOWER MOTORS

COMPLETE RANGE OF SIZES . . .



SAVES ASSEMBLY TIME AND LABOR!

Made in a complete range of standard and special sizes for fractional H.P. motors.

PHOENIX Brush-Holders have been used for years by many of the country's leading motor manufacturers. They have proven themselves *in the field* under almost every condition.

Improve your operation, cut your costs, investigate PHOENIX.

PHOENIX ELECTRIC MFG. CO.
711 W. LAKE ST. CHICAGO 6, ILL.

ERIE ALLOY BOLTS to ORDER

ERIE specializes in bolts that depart from the standard in composition, heat treating, threading or size. We have been doing this specialized "bolting" work for 37 years for American Industry. Whatever your special bolt requirement from the husky hold-down alloy bolt or the close tolerance ground finish alloy steel Connecting Rod Bolt for Diesels to the smallest, ERIE is geared to meet your specifications. Send your blueprints today.

Representation in Principal Cities

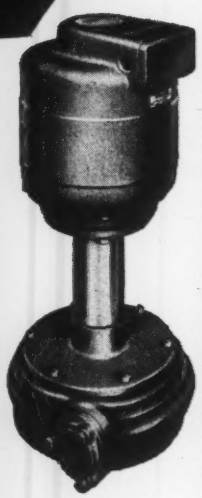
ERIE BOLT & NUT CO.
ERIE, PA.

A SUBSIDIARY OF Barium STEEL CORPORATION
Steelwright to the Nation

STUDS • BOLTS • NUTS ~ ~ ALLOYS • STAINLESS • CARBON • BRONZE

RUTHMAN GUSHER MACHINE TOOL COOLANT PUMPS

The Right Way to Higher Profits FOR YOU!



You're protecting your production and profits when you use Ruthman Gusher Coolant Pumps on your metal-cutting machinery. Ruthman Gusher Pumps offer you an advanced design that assures you superior performance under the demands of stepped up production. And you know when it's a Ruthman Pump, it's built to last.

Write us today. There's a Gusher type and model to fit your coolant problem.

THE RUTHMAN MACHINERY CO.

1811 Reading Road Cincinnati, Ohio

How Much Less Does an Engineered Clutch Cost?

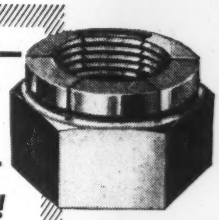
An engineered-to-the-job ROCKFORD CLUTCH application involves recommendations covering the proper type—spring-loaded, over-center, multiple-disc, gear-tooth or splined-to-shaft drive—as well as torque rating, shock-load absorbtion, slippage control, vibration dampening and provision for frequent drive shaft reversals. Regardless of your needs, ROCKFORD CLUTCH engineers can specify a size and type clutch that will operate most efficiently in your product—conserving space, power and final cost.

ROCKFORD Over-Center CLUTCHES

ROCKFORD CLUTCH DIVISION
BORG-WARNER
311 Catherine Street, Rockford, Illinois

A fastener AIN'T, *if* — *it works loose.*

The "FLEXLOC" IS — *because it won't!*



FLEXLOC

ONE-PIECE, ALL-METAL
STOP- and LOCK-NUT

Its "chuck-like," resilient locking segments lock the "FLEXLOC" securely in any position on a threaded member with a controlled, uniform and dependable torque.

Tough applications demonstrate that the "FLEXLOC" positively "won't work loose", yet it can be removed easily with a wrench when desired. Because it is all-metal, temperatures as high as 550°F. hold no terrors for the "FLEXLOC."

The "FLEXLOC" has plenty of tensile . . . can be re-used many times . . . has therefore a long, effective life.

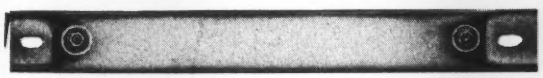
Write for further information and free samples.

SPS — STANDARD PRESSED STEEL CO.
JENKINTOWN 18, PENNSYLVANIA

VULCAN

ELECTRIC HEATING UNITS

STRIP HEATERS



For heating FLAT SURFACES—SHALLOW PANS—POTS—HOT PLATES—PLATENS—PLASTIC EXTRUDERS — OVENS — MELTING POTS—PACKAGE SEALERS—TANKS—DIES, etc.

CONSTRUCTION

SHEATH—one-piece, rust-resisting rectangular tubing.

HEATER COIL—nickel chromium wire, insulated from inner sheath with a refractory selected for best thermal conduction.

TERMINAL SCREWS—stainless steel.

VOLTAGE, 115 and 250

16 STOCK SIZES, from 150 watts, 8" overall length, to 1250 watts, 41⅜" overall length.

STEEL SHEATH for temperatures up to 750° F, max.

HIGH TEMPERATURE SHEATH for temperatures up to 1200° F, max.

FIVE TERMINAL ARRANGEMENTS.

VULCAN ELECTRIC COMPANY
DANVERS 6, MASS.

Makers of Vulcan Electric Soldering Tools, Electric Solder Pots, Electric Glue Pots, Electric Branding Irons and Electric Heating Units, including the new Vulcan 900 series for changing over any hot water heater to electric operation.

OVERLOAD PROTECTION?

it's a Snap with CHACE BIMETAL

No. 46—Product of Westinghouse Electric Corp. Mansfield, Ohio

A disc of Chace Thermostatic Bimetal provides immediate dependable protection against motor burnouts due to overloads in this new Westinghouse automatic washer, the "Laundromat".

The thermostatic bimetal disc and a heating element are mounted on a shaft which actuates a line switch in the timing mechanism. Should an overload occur, the heating element heats the bimetal disc, causing it to snap inward against a collar fixed to the shaft; this moves the shaft inward to open the line switch in the timer, stopping the "Laundromat". To re-start, the operator pulls out the control dial, re-setting the overload switch.

The dependable response of this actuating element of Chace Thermostatic Bimetal backs up the well-known slogan: "You can be SURE . . . if it's Westinghouse." And *you*, too, can be sure . . . with Chace Thermostatic Bimetal! If your product can be controlled by changes in temperature, take advantage of the services offered by our engineering department. These include assistance in the design of an actuating element for your product, laboratory tests of its performance, and recommendations for production methods. Get specific recommendations for *your* product from the Chace Application Engineer.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

Collector Rings

WELCO Collector Rings are made in all sizes to carry currents of 5 to 200 amperes. Two to twelve rings can be furnished on one stub complete with brush holders, brushes, studs for supporting the brush holders and stud rings. The collector rings can be assembled as a unit on one hollow tube with threads on one end and insulation bushings on the opposite end. The brush holders carrying the current are made of brass. The collector rings are made of hard bronze material. Bakelite insulation is used.

Welco Collector Rings are custom-built to fit the special design and functional requirements of your machines or equipment. A limited number of standard types are available. Send us your blueprints and we will design for you the collector rings that are functionally correct.

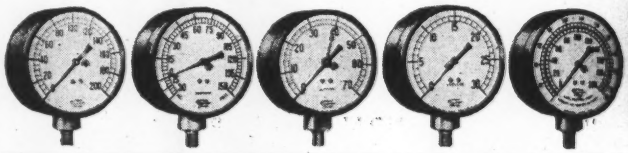
THE B. A. WESCHE ELECTRIC CO.
1620-20 VINE ST. CINCINNATI 10, OHIO

the right answer

. . . to every gauge need IN THIS NEW CATALOG

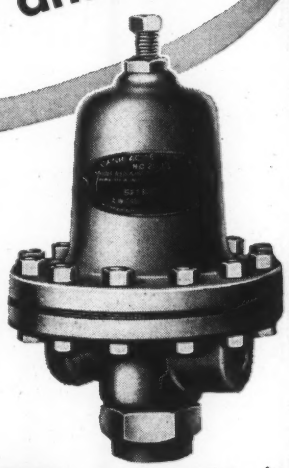
The right answer—the Marsh answer — to every pressure gauge need is described by this new Marsh catalog which covers hundreds of variations of styles, types, mountings, ranges, functions. Remember that Marsh gauges, from the "Standard" series line to the heavy-duty "Mastergauge" series have proved across the years to be the most economical you can buy for a given set of conditions. Let us prove this in terms of gauges for your product.

MARSH INSTRUMENT CO.
Sales affiliate of
Jas. P. Marsh Corp., Dept. B, Skokie, Ill



The problem... The answer...

How to reduce pressures as high as 2,500 pounds down to working pressures. Cash-Acme Type LS Pressure Reducing Valve will do it. This valve is ALL BRONZE—with Nitralloy trim for longer service.

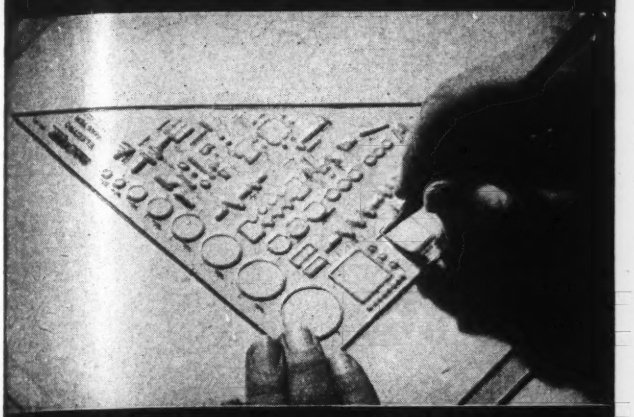


CASH-ACME *Automatic Valves*

Ask your Mill Supply dealer for information about the FULL LINE of Cash-Acme Automatic Valves.

A. W. CASH VALVE MANUFACTURING CORP.
6613 EAST WABASH AVENUE DECATUR, ILLINOIS, U. S. A.

Z32.3-1946



NO. 175 ELECTROMASTER

ALL ELECTRICAL SYMBOLS SHOWN IN THE AMERICAN STANDARDS ASSOCIATION MANUAL Z32.3-1946, AS WELL AS OTHER ACCEPTED SYMBOLS IN THE UTILITY, POWER AND LIGHT FIELDS CAN BE MADE WITH THIS TEMPLATE.

MADE OF MATHEMATICAL QUALITY PLASTIC SHEETS LAMINATED TO .080 THICKNESS. INNER CONTOURS BEVELED. PRINTING IS BETWEEN THE LAMINATED SHEETS.

ONE OF THE MORE THAN 30 RAPIDESIGN TIME-SAVER TEMPLATES—ALL OF WHICH ARE BETTER MADE, MORE USEFUL AND LESSER PRICED.

$4.00 AT YOUR LOCAL DEALER

CATALOGUE NO. 49 AVAILABLE UPON REQUEST

RAPIDESIGN INC.

P. O. BOX 592 • GLENDALE, CALIF.

Metron

ZERO-BACKLASH

MINIATURE SPEED CHANGERS WITH HOBBED GEARS!

Single-section unit illustrated ¾ ACTUAL SIZE!

ZERO-BACKLASH Metron Miniature Speed Changers are equipped with precision-hobbed, case-hardened steel gears . . . Ideal for use in precision instruments, counting devices, regulators, controls and other equipment requiring high accuracy in small, light weight fixed-ratio speed changing. Zero backlash is obtained by spring-loading parallel gear trains against each other, so that backlash is taken up continuously. Write for Bulletin No. 100, containing full specifications and prices.

- **STANDARD RATIOS** from 10/9 to 3375:1!
- **COMPACT!** Only 1.050" diameter; single-section types only 3 1/16" overall!
- **STAINLESS STEEL** ball-bearing drive shafts, permanently lubricated.
- **SPEEDS** up to 20,000 RPM on high-speed shaft!
- **PROMPT DELIVERY** on all Standard Ratios.

METRON INSTRUMENT CO.

442 Lincoln Street — Denver 9, Colorado

Ask for data on other Metron Miniature Components.

BUILT BY Metron MAKERS OF INSTRUMENTS FOR PRECISION MEASUREMENT

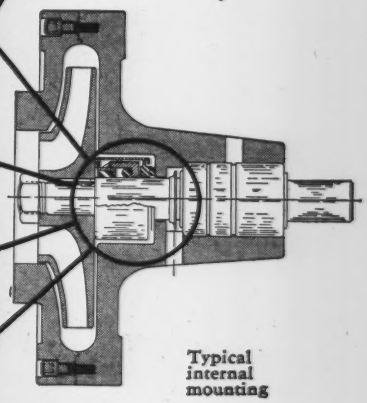
NOW! *Simplify your Designs—*

"Sealol" CB

THE COMPLETE MECHANICAL SEAL

SINGLE UNIT CONSTRUCTION

NO SEPARATE PARTS



Typical internal mounting

Construction Features

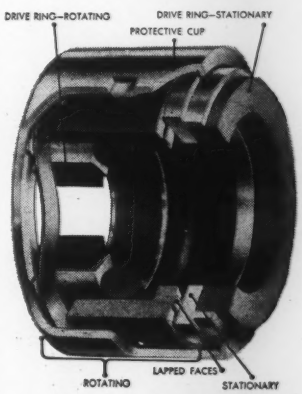
- Complete mechanical seal in one package
- Corrosion-proof materials
- Factory-assembled, factory-tested
- Lapped running faces fully protected
- Compact . . . requires minimum space

Installation Features

- Hand assembly . . . no press fits
- No special tools or skill required
- Quickly, simply installed as a unit—no loose parts
- Fits accurately without precision machining
- Running faces protected—cannot be damaged by mishandling
- Internal or external mounting

Operation Features

- Permanent sealing—no packing to adjust—no scored shafts
- "Sealol" balanced-pressure design—maximum seal life
- Seals wide variety of liquids
- Minimum frictional drag—low torque
- Pressures in excess of 100 psi . . . speeds to 10,000 RPM



"Sealol" CB Seals are recommended for pumps — water, oil, boiler feedwater, gasoline, aviation fuel—for compressors, gear boxes, washing machines, etc. For "Sealol" Drwg B-7100 giving complete dimensional information and for engineering recommendations and bulletins, address Sealol Corporation, 45 Willard Ave., Providence 5, R. I.

SEE AND CATALOG FILE SHEETS

SEALOL

Chicago • Cleveland • Detroit • Los Angeles
New York • San Francisco

* Fluid Power Improves Production

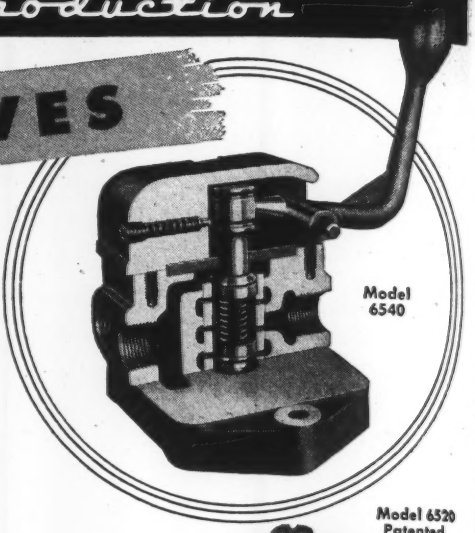
"LOGAN" AIR CONTROL VALVES

79 MODELS

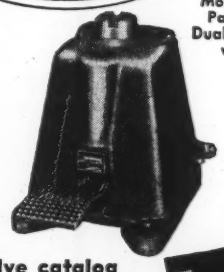
MOST MODELS STOCK DELIVERY

Check these Features!

- BALANCED PISTON DESIGN
- SELF-CLEANING
- COMPACT DESIGN
- EASILY INSTALLED
- MINIMUM DOWN TIME



Model 6540



Model 6520 Patented. Dual-purpose valve.

Logan SAVES ★TIME ★EFFORT ★MOTION

Air and Hydraulic Equipment

LOGANSPORT MACHINE CO., INC.

811 Center Ave. Logansport, Indiana

***ENGINEERING SERVICE**

Ask for Logan engineering assistance in designing complete air circuits. No obligation.

FREE CATALOG

Send for your free copy of air control valve catalog No. 100, Section 4. Contains complete listing plus illustrations and diagrams.

FLUID POWER SPECIALISTS SINCE 1916

SCREWS

Machine, Wood, Cap, Lag, Set, Knurled and Thumb Screws

Brass, Bronzes, Aluminum, Monel, Stainless Steels

Large stocks ready for immediate delivery from distributors and warehouses in principal cities.

FREE CATALOG

The H. M. Harper Company,
8202 Lehigh Ave.
Morton Grove, Ill.

Please send your condensed catalog.

Name .....

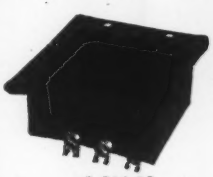
Company .....

Address .....

City ..... Zone.... State.....

For **HEAVY DUTY WORK!**
Severest Electrical Services

P-506-CE—Plug with Cap



S-506-DB
Socket with deep Bracket

JONES PLUGS & SOCKETS
500 SERIES
Proven Quality!

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

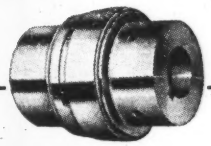
Socket contacts of phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. Made in 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (*rust-proofed*). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

Write for Jones BULLETIN 500 for full details on line.

Jones

HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

MORE H. P. per Dollar



(Heavy-duty Model "H" illustrated)

with LOVEJOY L-R *Flexible Couplings*

Couplings run quietly at high speeds without whip or backlash. There's no binding, no power-wasting. That's why you get more horsepower per dollar of coupling value. Resilient load cushions instantly accommodate misalignment. Cushions for every duty 1/6 to 2500 h.p. No lubrication.

LOVEJOY 50 YEARS CHICAGO

Write for the Lovejoy Catalog today . . . use the handy Selector Charts that quickly show you the coupling you need!

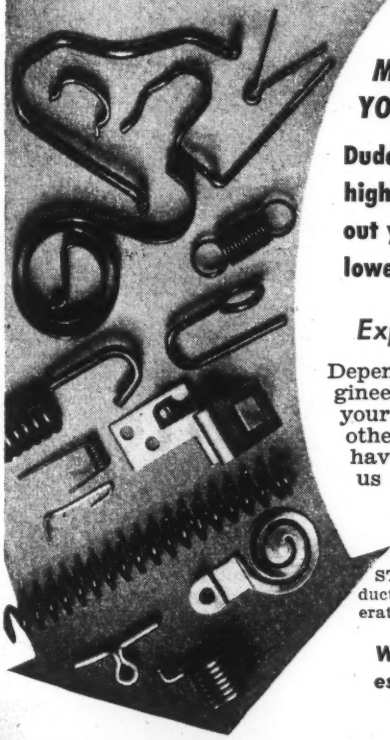
LOVEJOY FLEXIBLE COUPLING CO.

5018 W. Lake St. **Chicago 44, Ill.**

Also Mfrs. of Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

WIRE FORMS

COIL SPRINGS..METAL STAMPINGS



ACCURATELY MANUFACTURED TO YOUR SPECIFICATIONS

Dudek and Bock's precision high speed equipment turns out your work faster and at lower cost!

Expert Free Service

Depend on our master engineers for designs that fit your needs to a "T". When others have failed, we will have the answer. Consult us Today—no obligation!

Get quality SPRINGS, from gram loads to pound loads—WIRE FORMS and METAL STAMPINGS that save production costs and promote operating efficiency.

Write, wire or phone for estimates and speedy delivery dates!

Phone Haymarket 1-3676

2100 W. Fulton, Dept. M-2

Chicago 12, Ill.

DUDEK and BOCK

Specify these NEW G-E SILICONE RUBBER COMPOUNDS

for parts that must have

- ★ high tensile strength
- ★ high elongation
- ★ hot tear strength
- ★ excellent electrical properties

★ Now you can specify General Electric silicone rubber for parts where higher tensile strength, elongation, tear strength and electrical properties are important. Even *intricate* parts can be easily molded with the *new* G-E line of compounds. They offer greatly improved strength characteristics in addition to the basic properties of silicone rubber—exceptional resistance to heat, cold and chemicals.

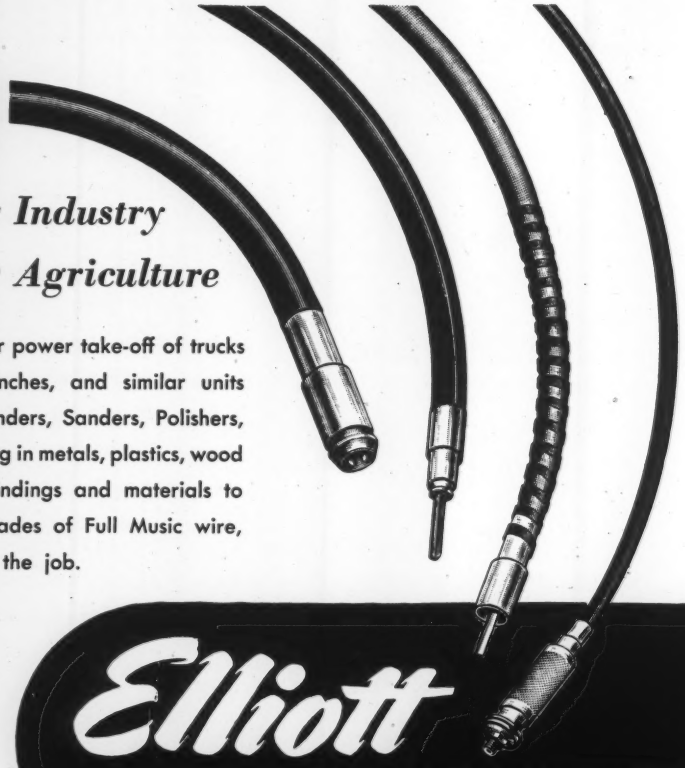
See your fabricator!

Be sure to ask your fabricator about this remarkable new line. He can help you improve your equipment or product by using this amazing new type of silicone rubber. For the names of fabricators in your area, write to Section Z5, Chemical Department, General Electric Company, Pittsfield, Massachusetts. (In Canada, Canadian General Electric Co., Ltd., Toronto)

GE SILICONE RUBBER

GENERAL ELECTRIC

FLEXIBLE SHAFTS ..for Industry ..for Agriculture



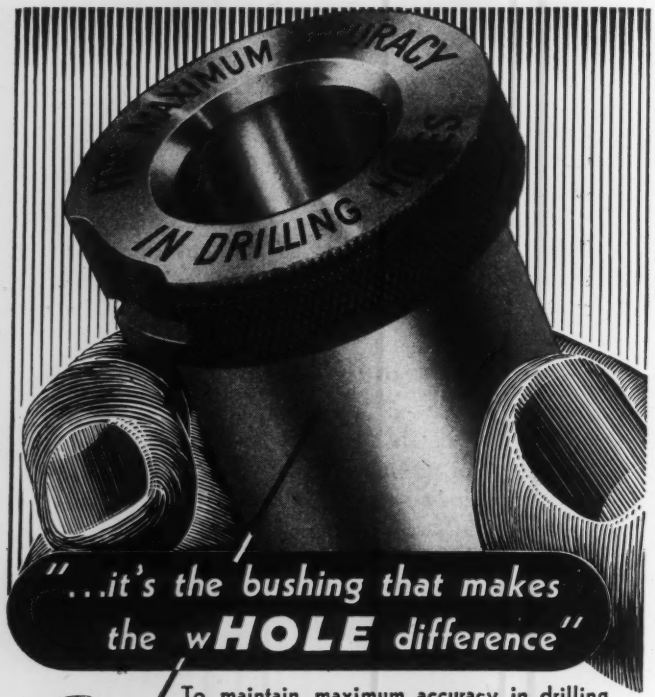
Elliott specializes in Heavy Duty Flexible Shaft units for power take-off of trucks and tractors, for operating pumps, compressors, winches, and similar units • Elliott supplies Flexible Shafts to builders of Grinders, Sanders, Polishers, Concrete Vibrators and other portable tools for working in metals, plastics, wood and ceramics • Elliott manufactures Cores with windings and materials to suit every particular requirement, using the best grades of Full Music wire, Stainless Steel wire, or High Carbon wire . . . to fit the job.

Elliott Engineering Service will help you select the type of Flexible Shafting and standard accessories which are best suited to your particular type of work. Inquiries are held in confidence, and this service is yours without obligation.

See our CATALOG in SWEET'S

Ask for Catalog 49
on your Company letterhead

Elliott
MANUFACTURING CO.
217 Prospect Avenue. Binghamton. N.Y.



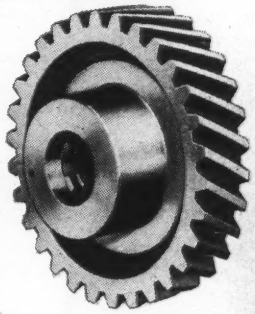
"...it's the bushing that makes the wHOLE difference"

To maintain maximum accuracy in drilling operations, use the bushing that's precision made for the job...use Acme. Write for catalog.

Acme Industrial Company
Makers of Hardened and Ground Precision Parts
211 N. LAFLIN STREET • CHICAGO 7, ILLINOIS
THE SERVICE SHOP TO INDUSTRY FOR MORE THAN 25 YEARS

Cincinnati Gears, Good Gears Only...

TO MEET *Your Specific* NEEDS!



Each Cincinnati Gear is made to fit a particular requirement from job specifications.

Cincinnati Gears, Good Gears Only, have the built-in accuracy and precision that make possible outstanding performance records.

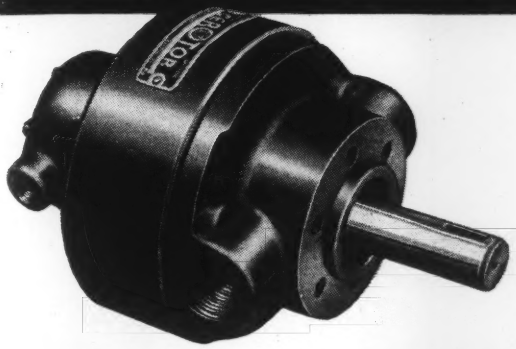
Let *Cincinnati Gears, Good Gears Only,* work for you . . . they will meet your every job requirement.

Spur • Helical
Rack • Worm • Bevel
Spline Shafts • Spiral
Internal • *Coniflex
Herringbone
Spiral Bevel

*REG. U. S. PAT. OFF

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
Wooster Pike and Mariemont Ave. • Cincinnati 27, Ohio

GEROTOR hydraulic MOTORS



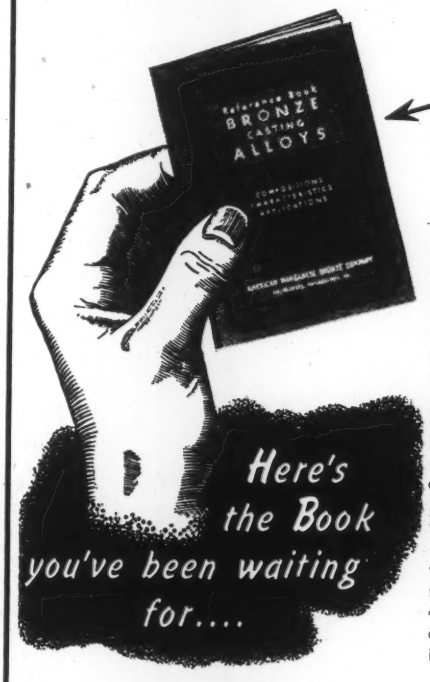
a rotary power source with unique advantages

GEROTOR Hydraulic Motors can be stalled under load without damage, operated safely in explosive and corrosive atmospheres, installed in confined spaces. Low rotational inertia. Two models with plain, base or flange mounting—for direct coupling, belt, chain or gear drive. Sizes up to 8.7 h.p. Write for Catalog G-108.

GEROTOR hydraulic pumps & motors

GEROTOR MAY CORPORATION, Baltimore 3, Md.

SENT TO YOU



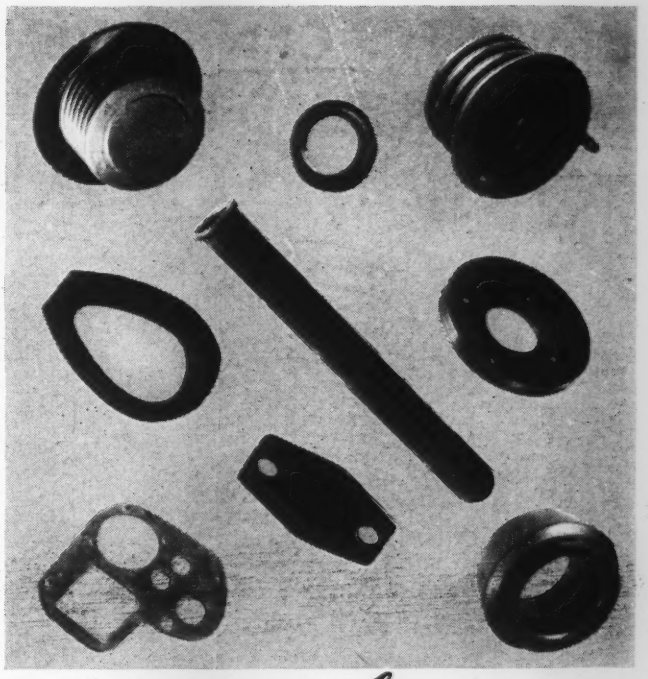
← free!

A 46-page, flat-opening, flexible - bound Reference Book that should be in the hands of every Engineer who specifies or uses Bronzes. Due to the cost of preparing and producing this useful book, we can only send it to those who request it in writing on their business letterhead—or of course, those who fill-in and mail us the coupon attached hereto — and remember, there's over 41 years "specialized experience" behind us in casting Bronzes.

American Manganese Bronze Co.
4715 Rhawn Street, Holmesburg, Philadelphia 36, Pa.

Please send me a copy of your latest "Reference Book of Bronze Casting Alloys"

Mr. .....
Firm .....
Title .....
Street .....City.....State.....



Acadia SYNTHETIC RUBBER

There is no great chemical secret nowadays about synthetic rubber. Its ingredients are generally known throughout industry. But there *is* a great difference in the methods, equipment, personnel and inspection in its manufacture. Acadia Synthetic rubber, wherever employed, is widely recognized as "tops."

Your Insurance Against Complaints

Practically all products in the durable goods fields are made up of many parts. Some have a very modest function and rarely are considered by the buyer. But when one of these components (synthetic rubber for example) is poorly made and service is required, the high reputation of your product suffers. So insist on the best—insist on Acadia Synthetic Rubber. Here are a few reasons: It is processed by the very latest mechanical equipment—is held to closest possible tolerances for non-metal cut and molded parts — unusual attention given to maintain uniformity of quality—maximum elasticity, resilience, plasticity—greater resistance to oil, heat, light, wear, age, etc.

Acadia Synthetic Rubber is available in sheets, tubing, strips, channel, extrusions, molded and cut parts, washers, seals, etc. Specify the particular characteristics desired. Acadia engineers are prompt in helping you determine the compound and qualities to best meet your requirements.

103R

DIVISION OF WESTERN FELT WORKS

ACADIA Synthetic **PRODUCTS**

Processors of Synthetic Rubber and Plastics • Sheets • Extrusions • Molded Parts

DIVISION WESTERN FELT WORKS

4035-4117 Ogden Avenue, Chicago 23, Illinois

DESIGNERS CAN PREVENT SCREW THREAD TROUBLES WITH *HELI-COIL*® INSERTS

ELIMINATE screw thread problems easily and economically with Heli-Coil Inserts of precision-formed stainless steel or phosphor bronze wire. They prevent abrasion, corrosion, seizure . . . they permanently protect threads against wear or stripping.

Heli-Coil Inserts permit design economies by saving weight and space . . . they improve any product on which they are used. They cut labor costs . . . make assembly easier . . . put added sales appeal into the product . . . eliminate thread failures.

Use Heli-Coil Inserts on all metals, plastics, ceramics and wood.

Write today for prices and detailed information.

HELI-COIL CORPORATION

Heli-Coil Corporation
47-75 — 35th Street, Long Island City 1, New York

Please send me ☐ Bulletin 650—on Design Data.
☐ Bulletin 349—on Salvage and Service.

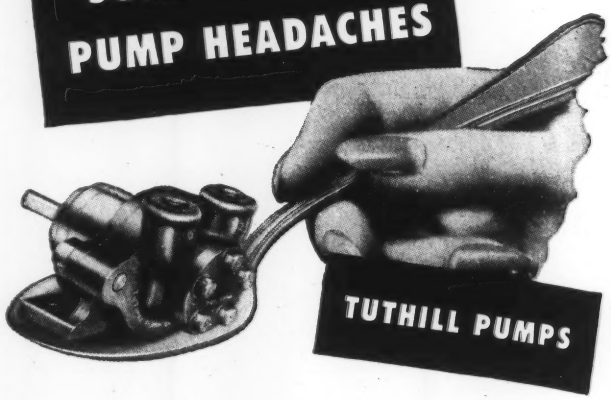
NAME.....

FIRM.....

STREET.....

CITY.....ZONE.....STATE.....

SURE CURE FOR PUMP HEADACHES



Forget pump worries. Tuthill small pumps are recognized the world over for their dependability in lubrication, coolant, hydraulic and liquid transfer service. These internal-gear type rotary pumps are available in capacities up to 200 g.p.m. and pressures up to 400 p.s.i. Wide choice of porting and mounting arrangements in both packed and mechanically sealed pumps. Write for General Catalog.

TUTHILL PUMP COMPANY
939 East 95th Street, Chicago 19, Illinois

GEARS

¼ in. to 6 ft.
All types—all sizes—to specifications

- Any quantity—one or a million
- Any precision you specify
- Gears or gear sets
- Modern plant—over 400 machine tools

SPURS
BEVELS—HELICALS
SPROCKETS—SPLINES
RACKS—SECTORS
WORMS
¼ in. to 6 ft.

Quotations gladly furnished—send us your blueprints. Ask for our equipment list.

UNIVERSAL GEAR WORKS INCORPORATED
Established 1910
16909 Livernois Avenue, Detroit 21, Mich.
Phone: UNiversity 4-8700

NAMEPLATE PROBLEMS?

FREE!

Send for this Manual of...

MEYERCORD DECAL NAMEPLATES

Meyercord Full-color "Mark-It" Manual of Decal nameplates contains 20 pages of problem-solving applications to any commercial surface.

WRITE FOR YOUR FREE COPY BUSINESS LETTERHEADS, PLEASE, DEPT. 33-12

Tested, Proven ways to Solve Nameplate and Marking Problems on any Surface

The most useful nameplate manual ever offered! In full color, it shows hundreds of uses for durable, washable Decal nameplates—as trademarks, instructions, charts, safety information or diagrams—in all sizes, colors and designs. Application is fast, easy and economical at production line speeds. On metal, glass, wood, china, plastics, leather, rubber, crinkle—curved, flat or flexible surfaces, Meyercord Decals provide permanent product identification at low cost.

The MEYERCORD Co.
World's Largest Decal Manufacturer
5323 W. LAKE ST. CHICAGO 44, ILL

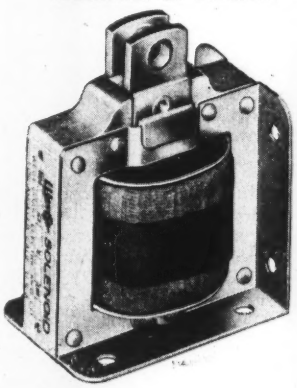
IDENTIFY • ADVERTISE • DECORATE

SOLENOIDS

AC or DC
Industrial or Aircraft

Vertical or Horizontal Mounting

Plunger Connections Bushed For Smooth Bearing Surfaces



Precision Designed For Long Life, Efficient Operation, And Compactness

Coils Easily Replaceable

These Solenoids incorporate Transformer Grade Silicon Iron, Stainless Steel Plunger Guides, Coils of Best Insulated Magnet Wire and Varnish.

Our engineers are ready to solve your particular design or application problem.

Write for new 200 series AC Solenoid brochure.

DEPENDABLE WesCo PRODUCTS SINCE 1927

WEST COAST ELECTRICAL MFG. CORP.
CENTURY & MAIN ST. LOS ANGELES 3, CALIF.

BEST BUY BROWNING

BETTER SHEAVES FOR BETTER DRIVES

BROWNING
Gripbelt Sheaves With Split Taper Bushings

Write for the name of the BROWNING distributor near you.

BROWNING MANUFACTURING COMPANY
INCORPORATED
MAYSVILLE, KENTUCKY

BEST BUY BROWNING

ENGINEERING PERSONNEL

needed for development of aircraft propellers, fuel controls, hydraulic pumps, air conditioning, etc. at

HAMILTON STANDARD

DIVISION UNITED AIRCRAFT CORPORATION

East Hartford, Connecticut

DESIGNERS — MECHANICAL

Minimum—5 to 7 years' aircraft engine or product design experience preferred; have extensive knowledge of hydro-mechanical mechanisms.

DESIGN ANALYTICAL ENGINEERS

3—5 years' aircraft engine or product design experience preferred; ability to calculate gearing, torque, friction and stresses.

Salary commensurate with training and experience

Send resume of education, background and experience to

Mr. R. J. Tierney, Personnel Dept.

HAMILTON STANDARD

East Hartford 8, Conn.

DRAFTSMEN

There Are

OPPORTUNITIES TO ADVANCE

at

BENDIX!

Electro-mechanical experience is desirable but not essential. Here's your chance to get into the ever-widening field of aviation engineering: rocket motors, jet engine accessories, engine control, aircraft instruments. Bright, modern plant. All inquiries in confidence. Apply or write:

BENDIX

Aviation Corp.

TETERBORO, N. J.

ENGINEERS

AVAILABLE OR WANTED

AVAILABLE: Product engineer for design and development of small, complex mechanical devices. Mechanical Engineers degree with honors. Age 38. Familiar machining and assembly problems. Now employed. Prefer small city or town about 10,000-50,000 population, Ohio, Pennsylvania, New York. Address Box 716, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

◆ ◆ ◆

AVAILABLE: Mechanical engineer. Graduate, registered in Ohio. Fifteen years engineering experience; full knowledge of gear cutting tool design, gear design and production; also, general tool and machine design. Desire supervisory position. Address Box 717, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

◆ ◆ ◆

WANTED: Development engineer. Mechanical. Engineer-designer with creative ability and at least seven years experience in the development of special purpose machinery and other production equipment. Experience in product development not desired. Good working conditions. Permanent. Please send resume to Box 713, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

◆ ◆ ◆

WANTED: Research and development engineers, mechanical, electrical, and electronic engineers and engineering physicists. Excellent positions on experimental research and development projects related to intricate electro-mechanical and electronic devices. Men with advanced degrees or equivalent experience may qualify for permanent positions in our laboratories in New York State. Give full details of education and experience indicating age and marital status. Address Box 709, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

◆ ◆ ◆

WANTED: Graduate engineers. Good opportunities for mechanical improvement engineers. Five or more years experience in machine design and development. Mechanical improvement work involving stress analysis, lubrications, vibrations and fluid dynamics with mechanical equipment such as pumps, compressors, agitators, bearings, drives, etc. Must be able to apply higher mathematics in solution of mechanical problems. For consultation and evaluation work. Give experience, education, age, references, personal history, salary received and salary expected. Please be complete and specific. All inquiries will be considered promptly and kept confidential. E. I. du Pont de Nemours & Co. (Inc.), Engineering Department Personnel, Wilmington 98, Delaware.

◆ ◆ ◆

WANTED: Hydraulic engineer. Top quality man experienced on light hydraulic machine tool design for development program by machine tool manufacturer in Cincinnati area. Ideal working conditions. In reply state experience in full. Address Box 715, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

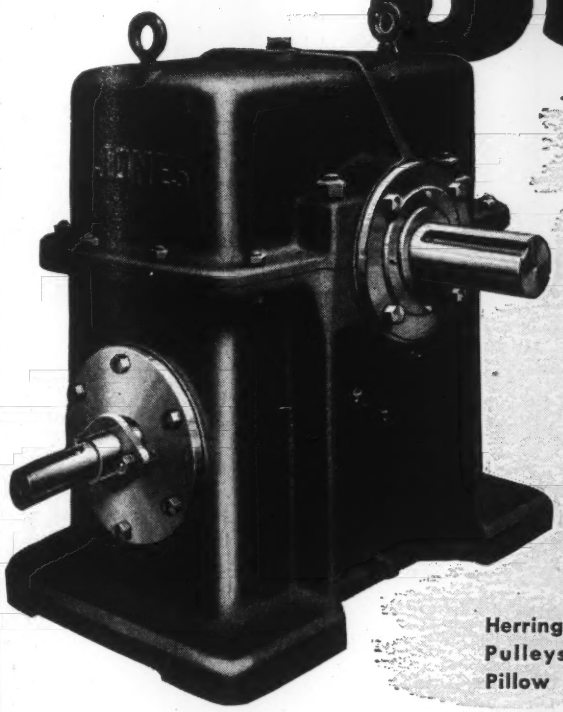
◆ ◆ ◆

WANTED: Machinery design engineer. Permanent employment with a leading Connecticut manufacturer of machine tools. Must have extensive experience in the design and engineering of lathes, grinders, and/or, milling machines. Send complete resume of qualifications and experience. Address reply to Box 714, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio. Interviews for qualified applicants will be arranged promptly. All replies will be kept confidential.

◆ ◆ ◆

WANTED: Mechanical research engineers. M. S. or Ph. D. in M. E. for research in mechanical engineering with emphasis on automatic special machinery. Must be outstanding technically and with at least a few years research experience. Give experience, education, age, references, personal history, salary received and salary expected. Please be complete and specific. All inquiries will be considered promptly and kept confidential. E. I. du Pont de Nemours & Company (Inc.), Engineering Department Personnel, Wilmington 98, Delaware.

Jones



WORM GEAR SPEED REDUCERS

A right angle unit built for heavy duty performance in any industry. The worm can be above or below the gear. Shafts are single or double extended for coupling connections or chain or gear drives.

They are built in ratios from 4 to 1 to 90 to 1 and in capacities from ¼ to 100 H.P.

Bulletin No. 68 covers selection tables and dimensions.

W. A. JONES FOUNDRY & MACHINE CO.
4413 W. Roosevelt Rd., Chicago 24, Ill.

Since 1890
Jones
In the Service of Industry

Herringbone — Worm — Spur — Gear Speed Reducers
Pulleys · Gears · V-Belt Sheaves · Anti-Friction
Pillow Blocks · Friction Clutches · Flexible Couplings

Just Published

Analytical Mechanics of Gears

By Earl Buckingham
Professor of Mechanical Engineering, M. I. T.

546 pages • 6 x 9 • $10.00

WRITTEN by an acknowleged authority in the field, this book covers every phase of the uniform transmission of motion and power by means of gears of all types. It covers the nature of the action—the forms of the teeth—the influence and nature of fraction—the conditions that influence the intensity of dynamic loads—the strength of the gear teeth—and the resistance to wear of various combinations of materials.

It is a book that will help you design more effective gears for any purpose. It includes spur and helical gears on parallel shafts, bevel and spiral bevel gears on intersecting shafts, and spiral, worm and hypoid gears on non-parallel and non-intersecting shafts. It provides a complete outline of the fundamental relationships that form the foundation of the design of all types of gears.

Order from:
Book Dept., Penton Publishing Company, Penton Building, Cleveland 13, Ohio

---

Abart GEARMOTORS

Here's an easy way to gear down speeds on equipment for pilot operations and development work—on agitators, conveyors, pumps, and other applications. You'll find Abart Gearmotors a big help to you. You get the *right* and dependable reduction at the right power. You get *better* operation, you save space by eliminating pulleys, couplings, belts, chains. Output speeds as low as 17½ R.P.M., 1/6 to 5 H.P., ratios 5⅘-1 to 100-1.

ABART GEAR & MACHINE CO.
4821 WEST 16th STREET, CHICAGO 50, ILLINOIS
Mfrs. of Gears and Speed Reducers

Write for **BULLETIN B250**

ADVERTISING INDEX

A

Abart Gear & Machine Co. 283
Accurate Spring Manufacturing Co. 229
Acme Industrial Co. 278
Aetna Ball and Roller Bearing Co. 196
Ahlberg Bearing Co. 215
Airborne Accessories Corp. 252
Alemite, Division of Stewart-Warner Corp. 181
Allegheny Ludlum Steel Corp. 81
Allen-Bradley Co. 45, 46
Allis-Chalmers 32
Allis, Louis, Co., The 83
Aluminum Company of America .37, 38, 39, 40
Aluminum Industries, Inc. 79
American Brass Co., The 65
American Crucible Products Co., The 248
American-Fort Pitt Spring Division, H. K. Porter Co., Inc. 208
American Hard Rubber Co. 218
American Machine and Metals, Inc., United States Gauge Division 12
American Manganese Bronze Co. 279
American Pulley Co., The 212
American Screw Co. 57, 285
American Steel & Wire Co. 94, 95
American Welding and Manufacturing Co., The 207
Anchor Coupling Co., Inc. 15
Armstrong Cork Co. 29
Automatic Electric Sales Corp. 49
Automatic Switch Co. 266
Automotive Gear Works, Inc. 34

B

Babcock & Wilcox Tube Co., The 233
Baldor Electric Co. 239
Baldwin-Duckworth Division, Chain Belt Co. 52, 53
Baldwin Locomotive Works, The, Standard Steel Works Division 26, 27
Barco Manufacturing Co. 221
Barnes-Gibson-Raymond, Division of Associated Spring Corp. 268
Barnes, Wallace, Co. 213
Bendix Aviation Corp. 282
Beryllium Corp., The 71
Bethlehem Steel Co. 66
Blake & Johnson Co., The 57
Boston Gear Works 80
Bound Brook Oil-Less Bearing Co. 206
Browning Manufacturing Co. 281
Bruning, Charles, Co., Inc. 216
Bunting Brass & Bronze Co., The 85

C

Cambridge Wire Cloth Co. 194
Camcar Screw & Mfg. Corp. 57
Carnegie-Illinois Steel Corp. 86, 87
Carpenter Steel Co., The 76
Cash, A. W., Valve Manufacturing Corp. . 274
Central Screw Co. 57
Chace, W. M., Co. 273
Chain Belt Co. 52, 53
Chicago Metal Hose Corp. 82
Chicago Rawhide Manufacturing Co. 2
Chrysler Corp., Industrial Engine Division 99
Cincinnati Gear Co., The 278
Clare, C. P., & Co. 185
Cleveland Worm & Gear Co., The 25
Columbia Steel Co. 86, 87, 94, 95
Continental Screw Co. 57
Cramer, R. W., Co., Inc., The 252
Crane Co. 44
Crucible Steel Company of America 55
Cuno Engineering Corp. 261
Cutler-Hammer, Inc. ..... Inside Front Cover

D

DeLaval Steam Turbine Co. 54
Delco Products Division of General Motors Corp. 70
Diamond Chain Co., Inc. 195
Dow Corning Corp. 187
Dudek and Bock 277

E

Eastman Kodak Co. 227
Eaton Manufacturing Co., Reliance Division 223
Elco Tool & Screw Corp. 57
Electrol, Inc. 230
Elliott Manufacturing Co. 278
Emerson Electric Manufacturing Co., The . 88
Erie Bolt & Nut Co. 272

F

Fafnir Bearing Co., The 96
Farrel-Birmingham Co., The 19
Fawick Airflex Co., Inc. 224
Federal Bearings Co., Inc., The 251
Federal-Mogul Corp. 92

G

Galland-Henning Manufacturing Co. 271
Gast Manufacturing Corp. 269
Gear Specialties, Inc. 8
General Electric Co. 58, 59, 106, 209, 253, 277
Gerotor May Corp. 279
Giannini, G. M., & Co., Inc. 269
Gilmer, L. H., Co. 18
Gits Bros. Manufacturing Co. 238
Gleason Works 5
Goodrich, B. F., Co., The 11
Goodyear Tire & Rubber Co., The 4
Gray Iron Founders' Society, Inc. 100
Great Lakes Screw Corp. 57
Greer Hydraulics, Inc. 234
Guardian Electric Manufacturing Co. 110

H

Hannifin Corp. 214
Hamilton Standard Division, United Aircraft Corp. 282
Harper, H. M., Co., The 57, 276
Hartford Special Machinery Co., The 201
Heli-Coil Corp. 280
Holo-Krome Screw Corp., The 190
Holtzer-Cabot, Division of National Pneumatic Co., Inc. 28
Howell Electric Motors Co. 102
Hyatt Bearings Division, General Motors Corp. 235
Hydraulic Equipment Co. 90

I

Industrial Engine Division, Chrysler Corp. 99

J

Johns-Manville 247
Johnson Bronze Co. 179
Johnson, Carlyle, Machine Co., The 237
Jones, Howard B., Division, Cinch Manufacturing Corp. 276
Jones, W. A., Foundry & Machine Co. 283

K

Kaydon Engineering Corp., The 193
Keuffel & Esser Co. 42, 43
Kohler Co. 240
Koppers Co., Inc., Fast's Coupling Dept. 61

L

La Plant-Choate Manufacturing Co., Inc. 72
Linde Air Products Co., The, Unit of Union Carbide and Carbon Corp. 51
Linear, Inc. 189
Link-Belt Co. 13, 107

Get the profit-protection of easy-handling, straight-driving, non-skid Phillips Screws . . . the modern fastenings that cut assembly time as much as 50%.

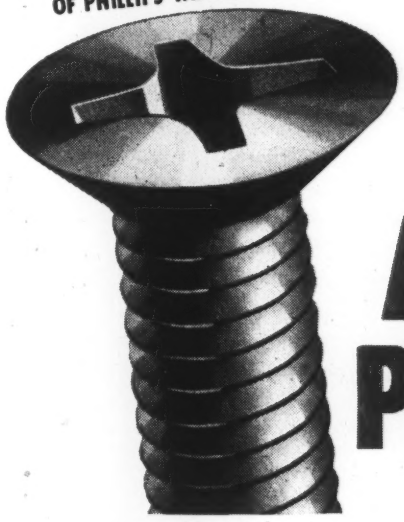
And get, *too,* the uniform quality, top "know-how" and unmatched research facilities that are the *special* advantages of AMERICAN Phillips Screws.

What's more, it's now better business than ever to "fasten with Phillips"... because the Phillips recess is being sold (every month, through the Saturday Post) as a buyer's guide to quality in all types of Phillips-fastened products.

And whenever you *think* of Phillips Screws, remember that it pays to *say:* "AMERICAN Phillips Screws!"

AMERICAN SCREW CO., Willimantic, Conn.

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS



AMERICAN PHILLIPS *Screws*

ALL TYPES
ALL METALS: Steel, Brass, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

ADVERTISING INDEX

Logansport Machine Co., Inc. 276
Lord Manufacturing Co. 220
Lovejoy Flexbile Coupling Co. 277

Mc

McGill Manufacturing Co., Inc. 222

M

Madison-Kipp Corp. 47
Mahon, R. C., Co., The 243
Manheim Manufacturing & Belting Co. .. 93
Marsh Instrument Co. 274
Massachusetts Gear & Tool Co. 240
Master Electric Co., The ....Inside Back Cover
MB Manufacturing Co., Inc., The 264
Mechanics Universal Joint Division, Borg-Warner Corp. 266
Metron Instrument Co. 275
Meyercord Co., The 281
Micro Switch Division of Minneapolis-Honeywell Regulator Co. 16, 17
Miller Motor Co. 109
Moraine Products, Division of General Motors Corp. 56
Morse Chain Co. 20, 21

N

National Bearing Division, American Brake Shoe Co. 241
National Erie Corp. 78
National Lock Co. 57
National Motor Bearing Co., Inc. 262
New Departure, Division of General Motors Corp. 6
New Hampshire Ball Bearings, Inc. 270
Norgren, C. A., Co. 48
Norma-Hoffmann Bearings Corp. 103
North Electric Manufacturing Co. 84

O

Ohio Gear Co., The 64
Oilgear Co., The 9
Omicron Co. 271
Orange Roller Bearing Co., Inc. 89
Ortman-Miller Machine Co. 248

P

Parker Appliance Co., The 226
Parker-Kalon Corp. 57, 287
Peerless Electric Co., The 202
Pesco Products Division, Borg-Warner Corp. 10
Pheoll Manufacturing Co. 57
Philadelphia Gear Works, Inc. 60
Phoenix Electric Manufacturing Co. 271
Porter, H. K., Co., Inc., American-Fort Pitt Spring Division 208
Precision Rubber Products Corp. 101
Pure Carbon Co., Inc. 200

R

RapiDesign, Inc. 275
Raybestos-Manhattan, Inc., Equipment Sales Division 91
R-B-M Division, Essex Wire Corp. 204
Reeves Pulley Co. 30, 31
Reliance Division, Eaton Manufacturing Co. 223
Resistoflex Corp. 198
Revere Copper & Brass, Inc. 288
Robbins & Myers, Inc. 67
Rockford Clutch Division, Borg-Warner Corp. 272
Rockford Screw Products Co. 57
Roper, Geo. D., Corp. 232
Ross Operating Valve Co. 1
Ruthman Machinery Co., The 272
Rynel Corp. 246

S

Schatz Manufacturing Co., The 217
Scovill Manufacturing Co. 57
Screw Research Association 57
Sealol Corp. 275
Shakeproof, Inc. 23, 57
Simmons Fastener Corp. 14
SKF Industries, Inc. 33
Skinner Purifiers Division of Bendix Aviation Corp. 269
Southington Hdwe. Mfg. Co., The 57
Speer Carbon Co. 244
Spencer Thermostat, Division of Metals & Controls Corp. 104
Sponge Rubber Products Co., The 203
Square D Co. 68, 69
Standard Pressed Steel Co. 265, 273
Standard Products Co., The 77
Sterling Electric Motors 246
Superior Carbon Products, Inc. 268

T

Telechron, Inc. 22
Tennessee Coal, Iron & Railroad Co. 86, 87, 94, 95
Thomson Industries, Inc. 228
Timken Roller Bearing Co., The .....105, Back Cover
Titeflex, Inc. 250
Tomkins-Johnson Co., The 98
Torq Electric Corp. 270
Torrington Co., The (Bantam Bearings) .. 41
Torrington Co., The (Specialty Dept.) ... 244
Tube Reducing Corp. 245
Tuthill Pump Co. 280
Twin Disc Clutch Co. 197

U

Union Carbide and Carbon Corp., The Linde Air Products Co., Unit 51
Union Chain and Manufacturing Co., The 74, 75
United Manufacturing Co., The 242
United States Gauge, Division of American Machine and Metals, Inc. 12
United States Graphite Co., The, Division of The Wickes Corp. 62, 63, 231
United States Rubber Co. 263
United States Steel Corp., Subsidiaries 86, 87, 94, 95
United States Steel Export Co. . 86, 87, 94, 95
United States Steel Supply Co. 86, 87
United States Testing Co., Inc. 238
Universal Gear Corp. 199
Universal Gear Works, Inc. 280

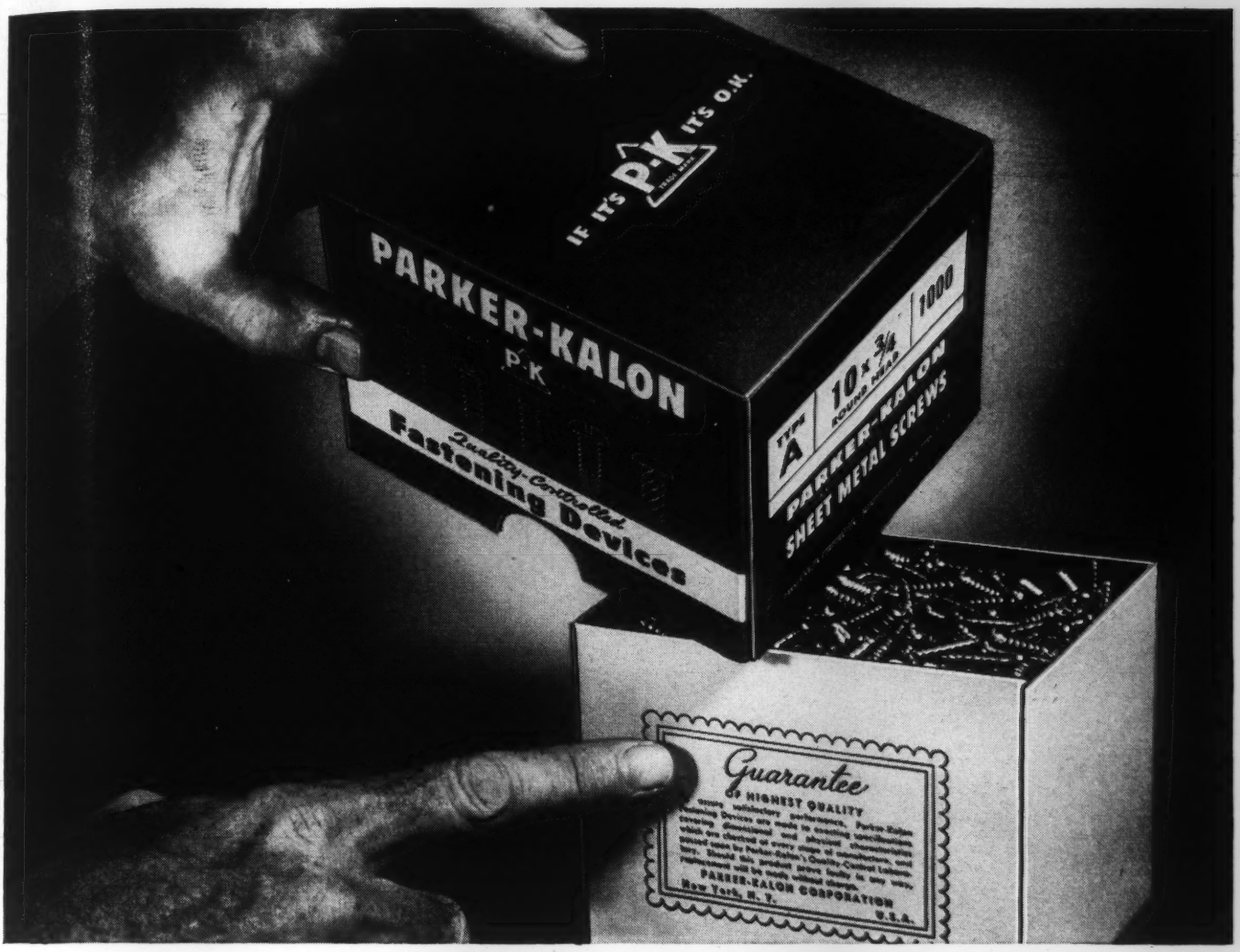
V

Van Huffel Tube Corp. 97
Veeder-Root, Inc. 24
Vickers, Inc., Division of The Sperry Corp. 205
Vickers Electric Division, Vickers, Inc. 50
Viking Pump Co. 270
Vulcan Electric Co. 273

W

Wales-Beech Corp. 57
Ward Leonard Electric Co. 210, 211
Warner Electric Brake & Clutch Co. 225
Wesche, B. A., Electric Co., The 274
West Coast Electrical Manufacturing Corp. 281
Western Felt Works 279
Westinghouse Electric Corp. 183
Wheelock, Lovejoy & Co., Inc. 236
Whitney Chain Co. 73
Wisconsin Motor Corp. 268
Wolverine Tube Division, Calumet & Hecla Consolidated Copper Co. 249
Worthington Pump and Machinery Corp. . 219

Engineers Available or Wanted 282



HOW TO UNCOVER EXTRA SAVINGS...

Most manufacturers today are aware of the advantages of using hardened Self-tapping Screws. They save time and simplify assembly by eliminating tapping for machine screws, by avoiding inserts in plastics, by using one operation fastening in place of bolting, riveting, soldering.

But they still may be missing some substantial *extra* savings, because all Self-tapping Screws are *not* alike. Planned savings don't always pay off.

Screws are a bit like people. If they lose their heads when under pressure . . . or turn out to be "softies" . . . or just don't "square up" on jobs, they can slow up a job for sure. You can avoid this by specifying "Parker-Kalon".

When Parker-Kalon developed the *first* Self-tapping Screws, over 35 years ago, they learned how to keep hardness and toughness properly balanced—how to make threads sharp and clean from head to point—in every screw. That's why every screw in every box can be *guaranteed* first quality.

Start making the extra savings you've been missing. Find out why the manufacturers of so many of the nation's best known products say, "If it's P-K* . . . it's O.K.!" A P-K Assembly Engineer will call at your request. Parker-Kalon Corporation, 200 Varick St., New York 14, N. Y. Sold everywhere through accredited Distributors.

*TRADE MARKS REG. U.S. PAT. OFF.

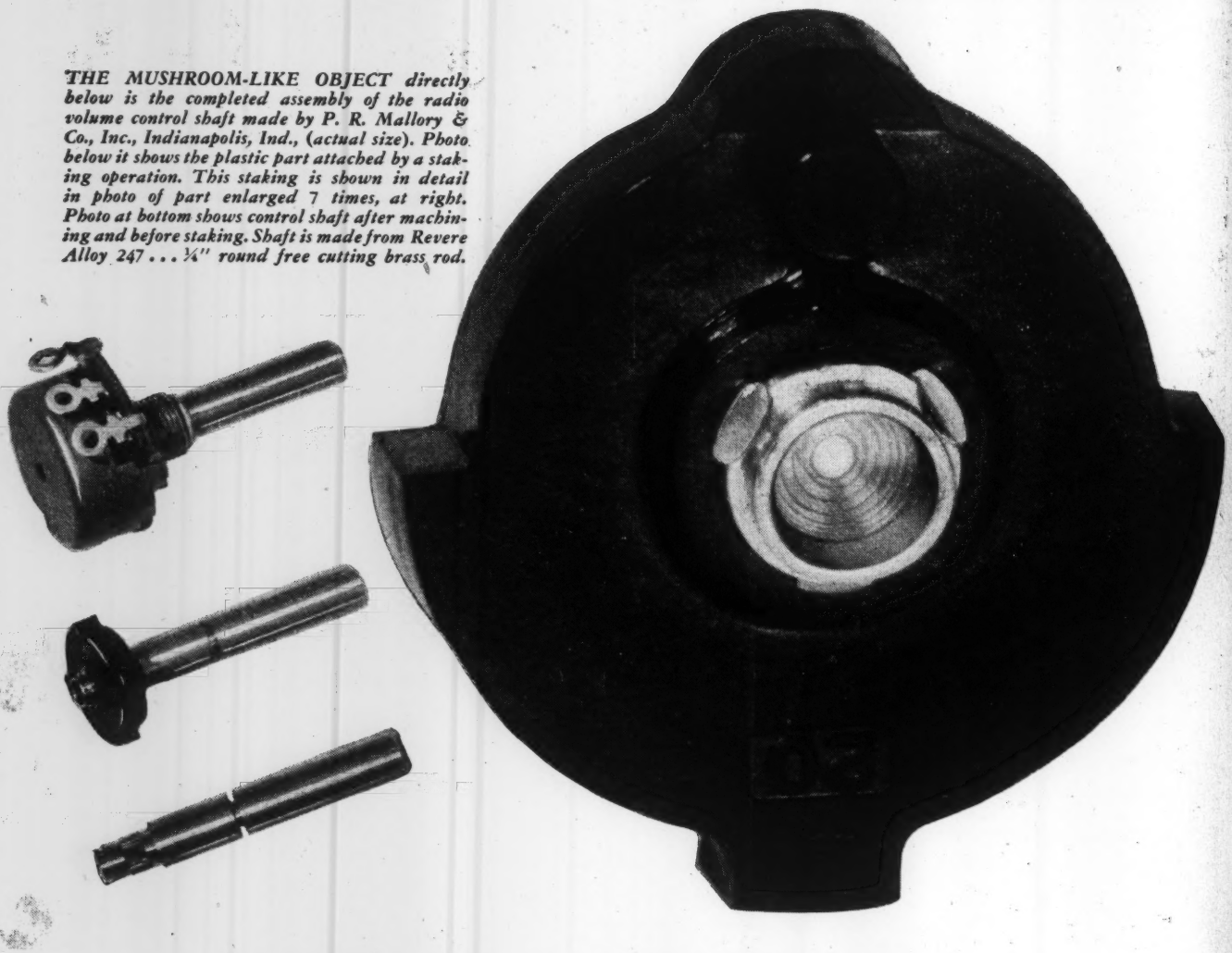
P-K TRADE MARK

The Original

PARKER-KALON* SELF-TAPPING SCREWS

OTHER P-K PRODUCTS: Cold-Forged Socket Screws, Wing Nuts, Thumb Screws • Hardened Screwnails and Masonry Nails • Shur-Grip File and Solder Iron Handles • Metal Punches • Damper Regulators and Accessories

THE MUSHROOM-LIKE OBJECT directly below is the completed assembly of the radio volume control shaft made by P. R. Mallory & Co., Inc., Indianapolis, Ind., (actual size). Photo below it shows the plastic part attached by a staking operation. This staking is shown in detail in photo of part enlarged 7 times, at right. Photo at bottom shows control shaft after machining and before staking. Shaft is made from Revere Alloy 247 . . . ¼" round free cutting brass rod.



BY SWITCHING TO REVERE FREE CUTTING BRASS ROD P. R. MALLORY & CO., INC.,

SAVES ON 2 COUNTS!

Staking operation on radio volume control shaft performed without fracture . . . annealing operation eliminated.

The solution to the Mallory Company's problem was not as easy as it might appear. It was not simply a case of Revere Technical Advisory Service recommending ¼" round, free cutting brass rod. That rod had to possess the machinability to match Mallory's existing production machine set-up and at the same time be sufficiently workable so that annealing, prior to staking, could be eliminated; and that staking be accomplished without fracturing the metal.

After consulting with the Mallory Engineers, and discussing the tests which Mallory would subsequently conduct, Revere recommended a ¼" round, half hard riveting and turning rod mixture 247. Working tests made by Mallory showed this rod to possess all the necessary requirements.

As a result of those tests, P. R. Mallory & Company is now using this Revere free cutting brass rod to its complete satisfaction for the radio volume control shafts it manufactures. Not just any ¼" brass rod, but the *right* rod made it possible for them to save on 2 counts.

Perhaps Revere has a brass, a copper or some special alloy to help you in the development or improvement of your product . . . in cutting your production costs. So why not tell Revere *your* metal problems? Call the Revere Sales Office nearest you today.

REVERE

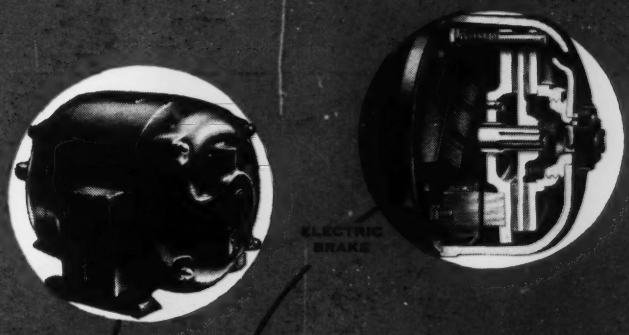
COPPER & BRASS INCORPORATED

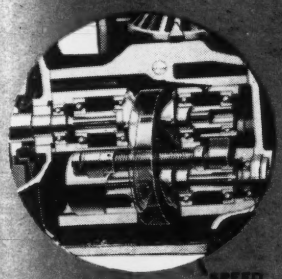
Founded by Paul Revere in 1801

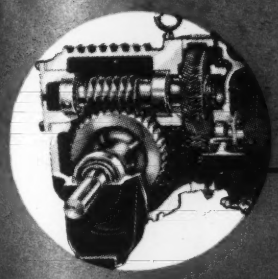
230 Park Avenue, New York 17, New York

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.







make a good job Better

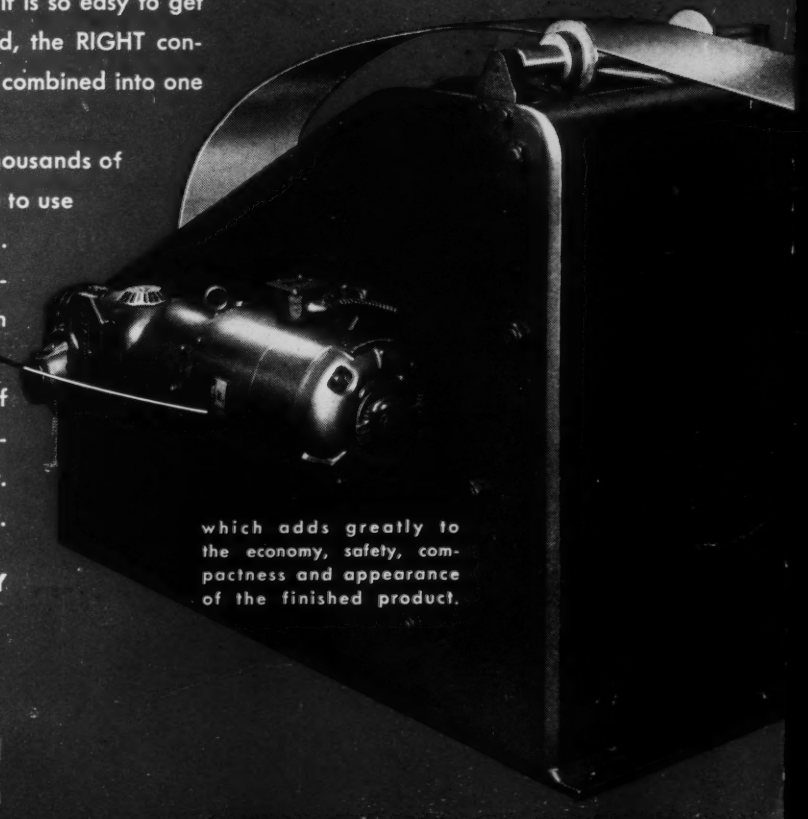
Don't put up with make-shift assemblies when it is so easy to get the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

Master Motors, available in thousands on thousands of combinations of types and ratings, permit you to use a power drive on each job that's just right . . . a power drive that will add greatly to the compactness, appearance, and economy of each of your applications.

Use Master Motors to increase the salability of your motor-driven products . . . improve the economy and productivity of your plant equipment. They're the horsesense way to use horsepower.

THE MASTER ELECTRIC COMPANY

DAYTON 1, OHIO



which adds greatly to the economy, safety, compactness and appearance of the finished product.

Trouble-free performance "as specified"

Cutler-Hammer Dimmers...

Architects and consulting engineers specify Cutler-Hammer Dimmers for beautiful lighting effects in churches, school auditoriums, lodge halls, restaurants, skating rinks, hotel lobbies and ballrooms, as they do for the nation's theaters.

Cutler-Hammer Breakerpanels...

Every type of building from the smallest home to the largest office building can now have convenient, inexpensive, modern Cutler-Hammer Multi-Breaker protection in place of troublesome fuses. Resetting a little lever restores service after overloads.

Cutler-Hammer Motor Control...

Modern buildings of every kind use many electric motors; for pumps, fans, blowers and scores of devices from complex air-conditioning systems to simple door openers. Architects, consulting engineers and electrical contractors have long shown a marked preference for Cutler-Hammer Control for these needs.

The modern building is far more than a mere shelter. As it comes into being from the architect's plans, it reveals itself as a carefully engineered "mechanism for human comfort and convenience". It incorporates a complete network of arteries for electric power . . . electricity for illumination, for ventilation, for refrigeration, for transportation, for communication, for heating, for pumping, etc.

The architects, engineers, and contractors who create these buildings know how much the trouble-free performance of electrical facilities means in shaping their reputations. As a consequence, Cutler-Hammer Motor Control has long been their outstanding choice for every building need. For more than a decade they have selected Cutler-Hammer Multi-Breakers as the perfect circuit protection for homes, and more recently have welcomed Cutler-Hammer Breakerpanels as the logical extension of this same protection to larger buildings. Today they are finding ever wider use for Cutler-Hammer Dimmers; not only in theaters but in churches, schools, restaurants, hotels, public buildings, even in homes . . . for beautiful variable lighting effects with remote pushbutton control. When the name plate says "Cutler-Hammer", you too can be sure of trouble-free performance "as specified". CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wis. *Assoc.:* Canadian Cutler-Hammer, Ltd., Tor.

Cutler-Hammer general purpose motor control is recommended by a majority of all electric motor manufacturers, is featured as standard equipment by machinery builders, is carried in stock by recognized electrical wholesalers everywhere.

CUTLER·HAMMER
MOTOR CONTROL
C-H